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Beekeeping for the Beginner in California

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Beekeeping for the Beginner in California

G. H. VANSELL[1]

INTRODUCTION

The University of California College of Agriculture has encountered a steady demand for elementary information on beekeeping. Heretofore this need has been met as far as possible with such publications as have been issued by the College, supplemented largely by bulletins and circulars from the United States Department of Agriculture. Information from the latter source does not, however, always cover the subject, because of the many peculiar local conditions.

The present non-technical circular describes phases of beekeeping in simple language for the layman and outlines what everyone should know when taking up the industry—as a source either of pleasure, or of profit derived from the honey and from a better fruit crop. As the amateur progresses in knowledge and experience, the information here given should be supplemented by any of the several excellent textbooks listed at the end of this paper, some of which will be found in almost any good city or county library. The present paper aims to give definite information as to beginning, getting equipment, and proceeding to get established. Variations of bee behavior, or of method, are not discussed. A choice of methods is likely to confuse the beginner and a contrast of different methods is bewildering and discouraging.

The College of Agriculture maintains at the University Farm at Davis an apiary of about seventy-five colonies for teaching students in agriculture and for experimental purposes. The scope of this work is being gradually enlarged to conform with the needs and the importance of the beekeeping industry in the state. It is expected that the results of experiments under way will be given in future publications of a more or less technical nature.

There are estimated to be over 15,000 beekeepers with 400,000 colonies in California, representing an investment of $10,000,000. Well over 50 per cent of the state's colonies are located in what is termed southern California. Seasonal rainfall fluctuates so sharply in the state that there are too many bees, particularly in the sage region, for the dry years. One year out of four is a failure in the sage so that migration is necessary. Where alfalfa is the chief nectar source the practice of irrigation reduces seasonal fluctuation. Northern

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California is less noted for honey production than for the production of bees and queens for sale to Canadians and to other western beekeepers living under severe winter conditions. The 1928 sales were 70 tons of bees and 75,500 queens.

Comparatively few persons are likely to become successful commercial beekeepers, as few possess the necessary temperament, the frugality, insight, and skill required. A prospective commercial beekeeper should go very slowly until he has had considerable actual experience. The majority of farmers and many residents of small towns can, however, successfully keep a few stands of bees with little expense and time.

Beekeeping in Relation to the Orchardist.—Perhaps the most important, but not the best known, work of the honeybee is the conveyance of pollen from flower to flower, thus assisting in the fertilization of plants, and assuring their fruitfulness. Bees are so necessary for the successful pollination of many fruit trees, nut trees, and seed plants that the growing of certain horticultural products has been handicapped by the recent decline in beekeeping. Among numerous reasons for the growing difficulty of successful bee culture may be mentioned, as chief, the wide dissemination of organisms causing death to the bee larvae and thus increasing expenses, and secondly, the replacement of vast areas of native nectar-yielding plants by the expansion of cultivation. In spite of the increased difficulties, however, the keeping of a few colonies of bees is still possible for many. It must be emphasized that bees will *not* "work free and pay their own board" as many uninformed enthusiasts suppose. Bees require consistent effort to keep them in good condition if they are not to become a complete nuisance and a focus of infection to other bees nearby. For the good of the industry, the smaller beekeepers should become familiar with bees, their habits, and their diseases.

Bees are conservationists. They supplement their extremely important service of pollinizing food and forage crops, by elaborating from the nectar of the plants thus benefited one of the most delicious, nutritious, and readily digestible foods. Hive bees, in addition to gathering nectar, must collect and store pollen in order to live and to rear their young. The body of the bee is provided with various modified parts for gathering, carrying, and manipulating the pollen. The relationship between bees and plants is here marvelously close for bees cannot live without the plant blossom products.

The pollination phase of beekeeping has been mentioned here to show the importance of the hive and other bees in the production of

fruit and nuts in California. For a discussion of the proper varieties of fruit trees and the approved manner of arrangement in the orchard, the reader is referred to our experiment station bulletins concerning pollination.

To serve effectively, colonies of hive bees must be strong. The heat required for the brood rearing of the colony is obtained in the cool weather of spring by the clustering of adult bees around the brood nest. Where the temperatures are low, as often during fruit blossoming time, only the strong colonies with an enormous number of adult workers can spare field workers from the brood cluster and so be of much importance in pollination. Packing colonies in insulating materials greatly reduces the number of bees required for brood warmth. The average price paid to beekeepers by fruit growers for bringing bees into accessible orchards during fruit blossoming time is from $2.50 to $3.00 per colony per season. The bees should be somewhat distributed through the orchard, in the most sunny exposures possible. A common recommendation is one hive to the acre, but much depends on the strength of the bees, the size, kind, and number of trees, and the weather. Some orchards will require more than this number and others a few less. The bees should be placed in the orchard in fall before wet weather makes hauling difficult.

Local Requirements for Beekeeping.—A location must have at least one major nectar plant to make honey production a success financially. In addition, bees require warmth and sunshine for a satisfactory crop of honey. Many coastal locations have a nectar plant but lack warmth, while inland conditions are often the reverse. The bees often lose a very early source of nectar because colony strength is increased too slowly in the spring previous to the flow. Familiarity with local conditions where bees are situated is an important step toward success. Weather Bureau records are helpful.

Beekeeping, though practiced for more than 3500 years, is surprisingly little understood today by the vast majority of even well educated persons. There still prevails a feeling that considerable mystery surrounds beekeeping although much information has been printed and specialists have developed the art to a nicety unsurpassed in any other branch of agriculture. During the past seventy-five years more actual progress has been made in beekeeping than perhaps during all the preceding centuries.

BEES AND THEIR HABITS

Varieties or Races.—All common hive bees in the United States belong to a single species, *Apis mellifica* Linnaeus. Several varieties of this species are, however, commonly called races as they interbreed freely—but few races are not somewhat crossed with others. All our hive bees have been imported from other countries. The commonest varieties of honeybees present in North America today are the Italian, the German or black, the Carniolan, the Cyprian, and the Caucasian.

Each of these varieties of bees finds ardent supporters. Most beekeepers, however, prefer the Italian bees of various types. The Carniolans perhaps rank second in popularity. The following brief statements indicate the color and the characteristics of the five races named.

The various types of *Italian* bees (originally imported from Italy) are rather distinctive in color, which is the basis of differentiation between the leather colored, three-banded, five-banded, etc. This color variation is quite noticeable in the several parts of Italy. Roughly, the color becomes progressively lighter to the south, so that the bees of Sicily are very pale yellow. The most popular strain in the United States today is the three-banded or leather-colored. Although the goldens are very pretty and usually gentle, beekeepers often find them not such good producers of honey as some of the other strains. The Italians, besides being fairly prolific, are comparatively resistant to European foulbrood. They winter well, produce well, and are gentler than many races.

The *Carniolans* (originally from Carniola, in Austria) are large, blackish bees with bands of silver white hair on the hind margins of the abdominal segments. This combination makes them appear gray. They are very gentle and extremely prolific, and winter well. Their rapidity of increase leads to excessive swarming unless abundant room for brood and storage is provided during swarming season.

A heavy demand for queens of a Carniolan-Italian cross has been manifested in recent years. Many of these queens are sold to Nevada beekeepers and to others at high altitudes where the wintering problem is somewhat difficult and the spring is late.

The *German* bees are small and black. The "Spanish bee" of California is thought to be this same old German type, brought into the state in early days by the Spanish Fathers. These bees are often vicious with both sting and mandibles. The waxmoth causes more

serious havoc among them than with the Italians, and they are particularly susceptible to European foulbrood disease. Although most beekeepers have, in consequence, attempted to abandon this race, traces of them are still prevalent in many parts of the state. The German-Italian hybrid is a very good combination.

Cyprians, from the Island of Cyprus, are of a bright orange tinge, of a smaller size than the Italians, and with a pointed abdomen of decidedly yellowish orange color anteriorly. They sting viciously and are not readily subdued by smoke. They have been thoroughly tested by American beekeepers, and now, though hard working and very prolific, they are being abandoned because of the difficulty in handling them.

The *Caucasians* introduced into America from the more northern parts of the Caucasus are largely of the gray type. Some are yellowish, resembling the Italians. Although very gentle, they protect their hives well against robber bees. They are very prolific, and in the main desirable. Their tendency to gather and use propolis lavishly and to build burr combs is quite noticeable. Their very unfortunate susceptibility to European foulbrood tends to limit their value in California. Despite these two drawbacks, many of them are in use today, especially in the southeastern United States.

Habits of Bees.—Every beekeeper should thoroughly understand the life history and habits of the honeybee. Numerous excellent textbooks and other publications on this subject make an extended discussion here scarcely necessary. Refer to the list of publications in the supplement to this circular.

Hive Organization.—The inmates of the hive, as is now usually well known, are of three kinds: one queen, a few dozen drones (in summer), and, in a strong colony, 40,000 or more workers.

The *queen* is the mother bee, her sole occupation being to lay the eggs that perpetuate the species. She is more nearly a slave than a queen. She lays two kinds of eggs, the fertilized ones which produce workers or queens (according to the food), and the unfertilized eggs which produce drones. She deposits from 2,000 to 3,500 eggs in a single day during the height of the breeding season. Queens live from three to five years or longer, but because of their decreased egg production they are usually unprofitable after the second year, when they should be replaced by younger stock. The queen possesses a functional sting, normally reserved for use against other queens, either mature or infant. A special section on queen rearing appears later in this circular.

The sole function of the *drones,* or males, is to fertilize virgin queens. They have no sting and perform none of the hive duties. Reared in the spring and summer in cells considerably larger than those of the workers, at the end of the season or during periods of dearth they are killed or driven out of the hive to perish. The queen's mating with a drone usually takes place in the air, the male dying immediately afterward. The spermatozoa received from the drone are stored in sperm reservoirs (spermathecae) in the body of the queen; from this stock are drawn sperm to fertilize the thousands of eggs which she deposits in the course of her life. The eggs laid in drone cells are unfertilized. Occasionally a queen, upon becoming old, exhausts her supply of stored spermatozoa, and thereafter all the eggs laid will hatch into drones. The same thing occurs in case a virgin queen is for any reason prevented from mating.

The *worker* bees (females undeveloped sexually and called neuters) are hatched from fertile eggs; but unlike the queen, who is fed for the whole of her larval life on very rich food, they receive, after the third day, a different, less nutritious diet. These workers undertake all the comb building, brood rearing, nectar and pollen gathering, honey making, and defense of the hive, tasks for which their bodies are especially fitted. While engaged in the strenuous activities of midsummer, each lives for about forty days; but during the winter the individual workers survive for several months, thus being enabled to start rearing young bees to replace them at the opening of spring.

Bee Bread.—This substance, composed of pollen mixed with enough honey to hold the grains together, is familiar to everyone at all acquainted with honey in the comb. Cells of bee bread occur scattered about through comb honey, and in the brood nest the cells of the whole frames will be found plugged with this material, which the young bees (larvae or grubs) require for food. The pollen collected by the bees from blossoms is carried to the hive in the "pollen baskets" on the rear legs; there it is kicked off into the cells, to be used in making bee bread. The large quantities of pollen required by a colony in rearing young are often not available because of the scarcity of pollen plants. In that case, brood rearing must be reduced, wherefore colonies in certain localities are at times too weak in numbers to gather a profitable honey crop. Figure 1 shows worker brood.

Development of the Individual Bee.—Table 1 shows the approximate time in days which each of the three kinds of individuals in the hive requires for development to maturity.

TABLE 1

DEVELOPMENT TABLE

	Egg	Larva	Pupa	Total days
Queen	3	5½–6	7–7½	15½–16½
Worker	3	5–6	12–13	21
Drone	3	6	15	24

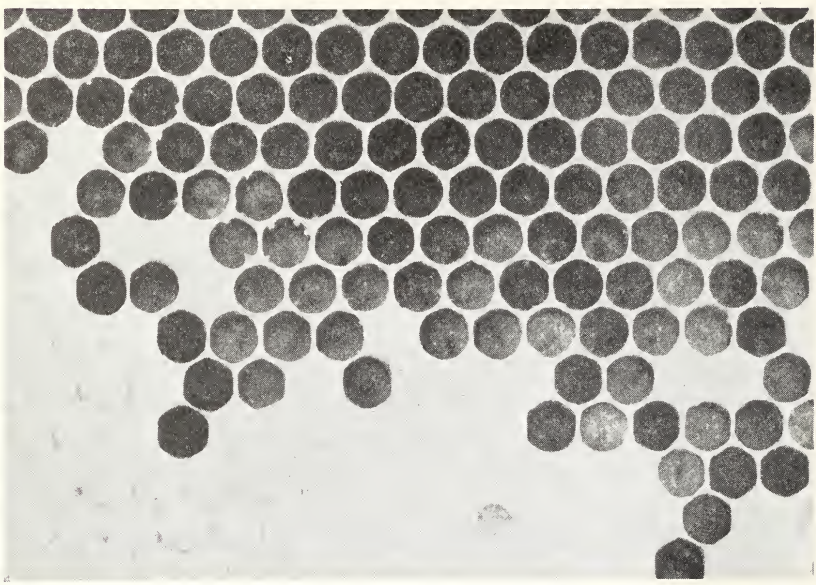

Fig. 1.—A close-up of comb from brood nest in which both sealed and unsealed brood are to be seen. Sealing or capping takes place when the larvae have finished feeding.

An insight into the machine-like instinctive activities and fixed habits of the hive bee may be obtained from the following records of Dallas Lore Sharp:

"In bee-civilization the state is everything, the individual nothing. Each one exists for no one. The individual is born to serve, and the moment he (she) ceases to serve, that moment he (she) dies—worker, or drone, or queen, even the unborn young in their cradle cells. For let hard times come knocking at the door, with more baby mouths to feed than there are stores to feed them from, and the tender young are torn from their warm beds and hurried to the outer cold. Let the last virgin queen of the season be mated and not only does that drone perish in the act, but all the drones in the hive no longer needed are bundled, bag and baggage, outside, to fumble for one pathetic moment

before they die at their own door. Let the worker come home with frayed wing, failing never so little of her full capacity production, and she is set upon, never to be seen again in the hive; let the queen-mother, in the height of the honey flow, come short in her prodigious task of keeping the colony at its maximum strength; let her fall off from laying her two to three thousand eggs per day, and a new queen is deliberately prepared for—the old mother, like any drone or worker, falling a victim to the pitiless polity of the state."

EQUIPMENT FOR THE APIARY

The Hive.—As great variety is to be observed in equipment, only essentials will be mentioned here.

Bees kept in ordinary boxes or in "bee gums" (hollow logs) are unprofitable because they cannot be given the necessary manipulation for honey production or disease control. The beginner must first provide himself with a movable frame hive of standard construction. These hives, simple in design and not patented, can be made at home, but the work is so systematically and nicely done by the manufacturers of bee supplies that most persons should buy rather than build.

The movable frame hive is a box, with a removable top and bottom, of proper dimensions for receiving the removable frames, placed so close together that the bees will leave only space for passage between the combs built in them. To encourage the building of straight combs, an artificial "foundation" of beeswax is secured in each frame. The frames with the combs built in may be removed at will and the honey extracted; a frame of brood or honey from a thriving colony can be given to a needy one, or the frames with brood and bees in one colony may be divided to make two. Many conveniences in handling bees thus result from the use of movable frames; others will occur to any beginner as he progresses.

The two hives in most common use are the eight and ten-frame size taking the Langstroth (9⅛ inches high by 17⅝ inches long outside) Hoffman size frame. Opinions differ as to the best size for general use in California, and in fact each is better under certain conditions. In actual practice, however, experienced beekeepers with different sizes and makes of hives under similar conditions find less difference in their honey crop than some published accounts would lead one to believe. If women are to handle the bees or if the hives are to be often moved (as in California) the 8-frame size has its advantages. On the other hand, the 10-frame variety affords more space for the rearing of brood and for the storage of honey. Some beekeepers,

indeed, favor even a larger "jumbo" hive and a deeper frame than the standard size; but the beginner need not concern himself about such matters. He should get a standard Langstroth hive and, generally speaking, the 10-frame size. Weather-resistant wood is preferable, especially for tops and bottoms. Painting the hives protects them from weather and thus greatly lengthens their life. White paint is usually desirable, because it helps prevent excessive heat in the colony during hot weather. Other light colors are satisfactory, but dark pigments such as black or red should never be used in hot localities.

For the production of comb honey on a small scale only a smoker, veil, and hive tool, together with the hives and bees, are needed. Some will want to begin with gloves, which, however, will soon be abandoned as too clumsy and hot.

Bee Smoker.—This contrivance, with bellows attached, serves for puffing smoke from burning cloth or other fuel free from sulfur into the hives. Sulfur kills the bees. A large-sized smoker should be procured because the small ones do not hold enough fuel.

Bee Veil.—Supply dealers sell many kinds of veils. The "Alexander" veil of black screen wire and cloth, which, worn either with or without a cap or small hat, will be found much cooler than a clinging veil of cloth netting. The important point is that beginners should get or make a veil of some sort to keep the bees away from the eyes and face.

Hive Tool.—Although a screwdriver will serve for prying off the cover and separating the frames, a regular hive tool soon pays for itself in convenience. The tool should be made of tough steel to withstand the pressure necessary in handling a badly propolised hive, and should be sufficiently long to reach well down inside the hive.

Other items of equipment will be wanted and needed as the beekeeper's knowledge develops.

STOCKING THE APIARY

How to Secure Bees.—Undoubtedly the best possible way for the beginner to obtain bees is by purchase of healthy stock from an established beekeeper. Two colonies will be found enough to start with. The apiary may be extended as the beekeeper gains experience. Each colony, if the location is good, will soon need an extra super, either comb or extracting. It is usually best to start with a view to producing comb honey, because less equipment is necessary. Most

localities in California are, however, far better suited to the production of extracted honey rather than comb. The change to extracted honey production can easily be made whenever the beekeeper's experience or enthusiasm warrants.

Another satisfactory method of obtaining bees is through purchase of new swarms. In this case the prospective beekeeper can obtain his hives (from the manufacturer or dealer) in the flat, nailing them together himself and thereby effecting a small saving. The following equipment should be ordered in winter and made ready long before swarming time (late spring):

2 hive bodies 8- or 10-frame size
16 or 20 Hoffman frames
2 hive tops
2 hive bottoms
16 or 20 full sheets of medium weight brood foundation
Spool of No. 28 wire for the frame wiring.
Complete comb honey super (or extracting super) for each hive.

After the hives are set up (according to the directions which will accompany them), painted, and dried, they may be taken to a beekeeper who will put in the swarms.

The purchase of package bees is not recommended for novices. For those somewhat experienced, no better method can be suggested.

Moving the Bees.—Bees remember a location so well that some difficulty is often encountered by the beginner in moving them to a new stand. They may be moved to a distance of one and a half miles or more without danger of their returning. One may transfer the colony to a point but a few yards away by advancing it a few inches each day. The bees may, furthermore, be taken far away to a new location for a week or two and then returned to any desired position in the old yard.

Bees excited by any disturbance generate a great deal of heat. During hot weather the hive cover should be removed and a "moving screen"[2] substituted, to allow the escape of excess heat that might melt the combs and kill the bees.[3] The temperature may be greatly reduced and the bees quieted if a little water is squirted into the hive through the screen.

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[2] Virtually a screen wire top in the place of a regular hive corner.

[3] Bees smothering in an overheated hive regurgitate the honey and water from their stomachs. This and not perspiration makes the whole dead mass of bees wet and sticky. The bees do this almost simultaneously, so that when the critical temperature is reached death results suddenly.

Location of the Apiary.—The location of the hives is of considerable importance. They should, as a rule, be faced away from the prevailing winds. They should be so placed that the morning sun will strike them soon, in order that the bees may become active early in the day, and thus gain an advantage by getting the first supply of nectar. In most localities in the interior of California the hives should, if possible, be shaded during the hottest hours. They should be so located that the bees will not annoy passers-by or disturb livestock. This latter precaution may save the beekeeper considerable

Fig. 2.—An out-apiary primarily for pollination purposes. The nearby foothills afford pasturage after the fruits are past blooming.

trouble, for the insects sometimes prove dangerous, especially to horses. Workers loaded with nectar or pollen fly best with the wind—a fact to be considered in placing bees for a given pasturage.

To keep more than 100 colonies in one apiary is usually not advisable, although in exceptional instances from 500 to 700 hives have been kept successfully in one yard. Apiary locations should be as far separated as feasible. If less than two miles apart in many areas, the bees from different apiaries will be working over the same ground, a condition undesirable from certain standpoints. Because of the many factors to be considered, however, no general rule can be given. The number of colonies any given locality will support can be ascertained only by study of the honey flora and the production record of that place. The beekeeper can then decide for himself the best number to be kept

and the proper placing from year to year. An orange location, for instance, may have marvelous carrying capacity during favorable periods. Under optimum conditions nectar drops from the trees so freely as to wet and make sticky the workers cultivating the grove; another year, this nectar may be relatively scarce and overstocking imminent.

Out-apiaries, or those located away from the main one, should be placed so as to facilitate transportation. Figure 2 shows an out-apiary in foothill country. The primary consideration, however, must be the available nectar supply and the number of colonies already near enough to draw on the resources. The out-apiary should preferably be near some friendly person, who will protect it against depredation and notify the owner in case of trouble. Sometimes it should be in the partial care of some one who can hive swarms or do other similar duties in an emergency. In most California locations, fire is an important danger during parts of the year. The terms under which an apiary may be placed on land belonging to another are a matter of mutual agreement. There is no general usage in this regard.

GENERAL MANAGEMENT OF THE APIARY

Avoiding Stings.—The sting is the bee's method of defense. A bee does not sting at random, as one might suppose, but at the sacrifice of its own life in an effort to protect the hive. A bee sting is so constructed that when thrust into mammalian skin it cannot be withdrawn. A bee away from the colony will not sting unless provoked.

Bees are nearly always "cross" on cool, cloudy days when they are unable to fly and gather nectar. They dislike sudden movements, so that all operations about the colony should be performed quietly. Avoid jarring the hive. As there is no prophylaxis against bee stings, the beginner must become accustomed to receive a few with grace until experience teaches him how to avoid them. A veil should always be worn. The proper use of smoke will help keep the bees quiet.

The sting fluid causes severe local pain and sometimes more serious effect. Where the heart is affected, adrenalin is administered hypodermically and a physician should be consulted as soon as possible. The sting stays in the flesh while the poison sac, pulled from the bee, is visible. One may avoid most of the poison by lifting the sting out with a knife blade rather than by pinching between the fingers.

Handling Bees.—The successful manipulation of bees depends entirely on knowledge of their habits. Very little basis of fact

underlies the old idea that bees lend themselves to manipulation by certain persons and can be governed according to a set of rules. Most of the older literature on practical beekeeping consists of such precepts. Rules, of course, must be based on the usual bee behavior, but it is far better to study the bees and learn their habits at first hand. Association with the insects gradually gives the beekeeper a wide knowledge of their habits and thus constantly enables him to solve the problems of manipulation. The best way to learn to handle bees is to put on a veil, light up the smoker, and make a start.

In working with a hive of bees, stand to one side and not at the front where the flight of the field bees would be interrupted. Before opening the hive, blow *a little* smoke into the entrance and then wait quietly for a minute. This smoke disarms the entrance guards, drives them in, and occasions a sound of alarm throughout the hive, whereupon the bees fill their stomachs with honey. In this condition they are much more agreeable and therefore easier to handle. Next quietly pry up the hive top and gently puff *a little* smoke under it to drive the bees down between the frames. The top now being lifted, the frame nearest the operator may be pried loose and taken out at will, the others being crowded together so as to give more room for its removal. Do not jar the frame or drop it. Lean it on end against the *back* of the hive out of the way, to avoid kicking it and at the same time to prevent crawling bees from coming up under the clothing. The frame on which the queen is found (and this is apt to be any of the frames containing eggs or brood) should not be placed down outside the hive, because of the danger of losing her. During the cooler parts of the year the frames should be replaced in the hive in exactly the same positions from which they were taken.

During manipulation stings should be avoided as much as possible, more because of the irritation of other bees by the odor of sting poison than because of pain to the operator. The first sting, which is a warning of others to follow, should be carefully avoided.

Quick movements tend to irritate bees. Novices, on approaching a hive, often strike at the insects which happen to fly toward them, or make other quick movements of the head or hand to avoid the dreaded sting. This rapid movement alone will attract other bees, and stings are very apt to follow. *Move slowly.*

The best time to handle bees is during the middle of a warm, sunny day when no desiccating wind is blowing. Never handle them at night or on cold, wet days unless in absolutely necessary preparation for moving or other operations. Bees should, indeed, not be handled unnecessarily at any time, for such disturbance always inter-

feres with their normal activities. The use of too much smoke troubles them so greatly that they will cease work for many hours.

Summary of Handling Operations.—Although many persons think first of stings when bees are handled, there is really little danger if a few simple rules are followed and a tolerably pleasant day is selected for the operation.

Beginners should:

Always use smoke in handling bees.
Stand at the side of the hive.
Not shake or jar the hive.
Not make rapid movements.
Wear a bee veil, not so much to protect the operator as to render him less nervous.
Lift and handle the combs slowly.
Treat the bees with consideration.
Examine the combs only when bees are flying freely.
Not wear gloves. They make for clumsy handling.

Swarming.—Bees swarm when the hive is full of brood and adult bees, and the incoming nectar is abundant. At such times they are apt to "hang out" on the front of the hive for several days before swarming. The swarming season in California is long, from March until September, but most swarming takes place during the months of April and May. When the swarm (consisting of practically all adults in a hive) comes forth, a great deal of confusion apparently occurs. The bees fly rapidly about in an unorganized fashion, but after a few minutes, if the queen is flying all right, the swarm becomes quieter and flies with a definite system. Before long a great mass of bees will settle of its own accord on some convenient place for further organization. They will move again after an indefinite time, ranging from a few minutes to several hours, and will now go, perhaps to a great distance, to a hive, a house, a tree, or other suitable shelter previously located by the "scouts."

Hiving the Swarm.—The best time to hive bees is when the swarm first clusters. If the hive suits their fancy they will remain and go to work. The hive must be *clean* and free from odors of oil, mice, chickens, and other smells possibly objectionable to bees hunting a clean place in which to live. In hiving, it is necessary only to cut off the branch on which they hang and shake them into or in front of an empty hive. They are very quick to notice a hive and will usually pass in contentedly. If the queen is observed during the hiving operations, the clipping of her wings before she goes into the

hive will eliminate the possibility of her leading the swarm away at a later date. The bees may also be prevented from leaving by placing a queen guard across the entrance after they have entered. The new swarm should be put in the permanent location during the evening after hiving because, if left for several days in the position where hived, they cannot then be moved without the usual difficulties encountered in transferring an old colony. New early swarms, especially when given drawn combs, are usually the most productive colonies in the apiary that season.

Swarm Control.—An excellent Farmers' Bulletin (No. 1198, U. S. Dept. Agr., Washington, D.C.), on this subject by Mr. George S. Demuth may be obtained free and should be studied by prospective or actual beekeepers. The essentials in swarm control practice are few. It must be remembered that swarming is a natural instinct; it is however, brought on by the surrounding conditions, which can be somewhat altered by the beekeeper. The elimination of crowding by judiciously supplying sufficient room and the maintenance of young queens will go a long way toward prevention of swarming. Excessive heat within the colony, another potent factor in swarming, may be reduced by using a shade board and increasing the opening for better ventilation. As swarming is much more common with some colonies of bees, the tendency in the apiary can be lessened by rearing queens from colonies disinclined to swarm freely.

Feeding Bees.—Often one must feed the bees, perhaps not to keep them alive, but in order to procure a maximum crop of honey. Feeding is not done to make honey from the syrup fed, but to induce brood rearing in a season of dearth so that a vigorous colony will be available when nectar becomes abundant; otherwise, brood rearing will be so greatly reduced that the colonies will lack strength to gather a profitable crop of honey. This may be illustrated by the condition prevalent in a great part of the Sacramento Valley. By the middle of April the bees build up from available field nectar in numbers to a point of great strength; swarming then becomes excessive. About the first of May, nectar is scarce. Many new swarms will actually starve and the parent colonies become weak before the middle of June, when alfalfa begins to yield. In addition, the bees still living will be too old to gather much nectar. Colonies fed during this period are in excellent condition to gather the alfalfa and star thistle nectar from the middle of June, through July and August. It is often possible, and cheaper, to move the bees into a good temporary location to avoid feeding. After eggs are laid, six weeks must pass before the bees are old enough to gather nectar. If a colony is short of feed, as

always after swarming activities, but few eggs will be laid. When a nectar flow begins, egg laying will suddenly increase, but the bees reared from these eggs will ordinarily not be old enough to gather much nectar before the flow stops.

What to Feed Bees.—Stimulative feeding should be done with a thin sugar syrup, of a consistency simulating that of fresh nectar. The best possible artificial bee feed is made from pure granulated white sugar dissolved in water. Two parts by volume of sugar to one of water make a satisfactory thin syrup for stimulation. Very often the best practice is to unite weak, hungry colonies with strong ones.

Uniting Weak Colonies.—Sometimes the beekeeper has on hand several weak colonies, perhaps swarms that issued late in the season, perhaps the result of queenlessness or other causes. Much may be gained and nothing lost by uniting them. Among many successful methods of uniting, one of the simplest is as follows: The queen should be removed from the weak colony, or, if a better queen than that of the stronger colony, she should be substituted for the poor one. The cover is removed from the colony with the queen, and a double thickness of newspaper put in its place. The bottom is taken from under the other colony, which is then set on top of the newspaper cover. Thus two colonies are housed on the same stand, separated only by the newspaper. The bees on both sides of the paper will immediately begin to gnaw it away, and by the time they have cut through and carried it out in front of the entrance (in twenty-four or forty-eight hours), they will have become "acquainted" and will not fight. They need not be assisted in removing the barrier, but during hot weather it may be necessary to provide for ventilation of the colony above the newspaper. This may easily be done by pushing match stems in between the paper and the edge of the upper hive body, thus leaving a narrow air crack, too small for bees to pass through.

Rendering Beeswax.—Although the combs and bracing built in the hives are largely composed of wax, more or less other materials are usually present. For example, the exuviae, bits of pupal silk, and old pollen grains, which absorb wax and hinder its complete extraction. The wax is readily melted by heat (at about 140° F) and in this state can be effectively pressed out with a screw-press. Most beekeepers, however, have no press and must extract the wax by hand. The accumulated broken combs, cappings, trimmings, etc., can be melted in a vessel containing boiling water; then the wax is freed from debris by straining through a cloth, in which the melted material is squeezed and twisted while still hot. Beeswax is lighter than water and, after hardening by cooling, may be lifted off in a marketable

condition. The "slum-gum," as beekeepers call the pressed residue, will still contain sufficient beeswax to warrant its shipment and sale. (Two cents a pound f.o.b. shipping point is paid for it at the time of writing this publication.)

Many beekeepers use a solar extractor, virtually a glass-covered box into which capping and broken combs are melted by the sun's rays. The wax drains away from the "slum-gum" by gravity. American foulbrood combs should never be melted in a solar extractor because of the danger that the causative organisms may be spread by visiting bees.

The uses to which beeswax is put are continually increasing. The price is high because no satisfactory substitute has apparently been found. All possible wax should be carefully preserved by the beekeeper for producing wax. It may be found most economical to practice rendering at one time only during the year. The waxmoth, a consumer of waxy wastes, may be readily prevented from destroying the stored material by an occasional fumigation with burning sulfur.

The European methods of wax extraction are much better than the American, especially from the standpoint of lessened waste. In Europe the wax is dissolved in one or another solvent, after which recovery is accomplished by distillation. This "extracted wax" is thought to differ somewhat, both physically and chemically, from the wax removed by melting.

Wintering.—Most beekeepers in California valleys incline to believe that special attention to wintering is unnecessary; as a result, the winter loss of bees is often a serious factor in their industry. Though statistics for California show actual percentage losses in colonies less than those in most states, the recorded loss is much greater than is necessary; in addition, the loss of individual bees within colonies is not shown in the available data. A sufficient amount of experimental work indicates that this latter loss is no small factor in California and in other states with mild winters.

The critical clustering temperature for a colony of bees has been determined by the Bureau of Entomology, Washington, D.C., to be 57° F. When this temperature occurs within the hive, the bees begin to cluster for the production of heat. As the temperature continues to drop, they gradually form a more compact cluster, until anyone looking into the hive would find them packed more tightly together than when, in summer, they hang on a limb in the form of a swarm. The bees inside the cluster are in violent activity, increasing the speed of their movements as the temperature outside goes down. This production of heat results in a rapid consumption of stores and a rapid

death rate. Any particular bee has (like a battery cell) just so much latent energy, and dies when this force is in any manner expended. At this point bees differ sharply from the better known warm-blooded animals which, when tired, readily renew their energy through resting and feeding. Reference to the weather records will show how often temperatures fall far below the critical point even in the relatively warm portions of California.

The universal requirements for successful wintering of bees are an abundance of young bees and of good food, with adequate protection from wind, moisture, and cold.

Fig. 3.—A winter packing case containing four colonies, two pairs back to back. The hive entrances are not closed. Planer shavings serve for the insulating material.

There are various methods of packing bees out of doors for winter. Cheap boxes may be made satisfactorily of waste lumber or old shipping boxes. A little more expensive cover, the 4-pack box recommended by the United States Department of Agriculture is most satisfactory (see fig. 3). This, when painted and cared for, may last twenty years or longer and is therefore relatively inexpensive; it is being used at University Farm, Davis, with excellent results. Satisfactory packing materials to be placed between the hives and the packing box are planer shavings, sawdust, dry leaves, hay, or other dry insulators. Attention to the placing of tunnels through the packing is necessary, for the bees must be able to emerge from the outdoor packing cases, where they do not remain so nearly dormant

as bees placed in dark cellars at about 45° F. Even slight protection during winter is better than none.

Extraction Equipment.—For those interested in good equipment, the nature and operation of some articles needed for extraction may be briefly discussed. It is understood that comb honey is stored in small square frames which are sold in their entirety; but the extracted product (often miscalled "strained honey") is thrown from the combs by centrifugal force, after which the combs are replaced in the hives for refilling. The extracted product must be stored in strongly built tanks, the storage of which need not be described. The principal articles of equipment concerned with extraction are an extractor (hand or power driven), an uncapping knife with the necessary boiler and heating apparatus, a cappings box or other container (a wash boiler with a suspended screen wire strainer is good), and a honey strainer to remove the particles of wax from the liquid as it is drained from the extractor either by hand or through a honey pump.

Before extraction, the honey must be removed from the colonies. When bees are being shaken from the combs, a slight upward movement of the frame, followed by a quick reversal and downward shake, will result in dislodging a greater proportion of insects. As combs filled with sealed honey cannot well be shaken effectively, most of the bees on them will have to be brushed off, like all bees remaining on the combs after shaking. Some form of covered carrier should at once receive the combs freed from bees. The comb box may advantageously be mounted upon a cart or wheelbarrow.

Uncapping and Extracting Honey.—Honey should be uncapped and extracted while still warm from the hive. A sharp knife is important for speed and effective work, and a knife both wet and hot will uncap with greater effectiveness. One should select combs of about equal weight for balancing in the extractor in order to reduce vibration when centrifuging. In the case of heavy (full) combs, particularly those newly built and not yet strengthened by use in brood rearing, the extractor should be turned only slightly at first, just enough to lighten them, and then reversed, after which the first side may be brought around again for final cleaning up. In this way new combs may be progressively lightened and the danger of breaking along the top may be greatly reduced.

Newly extracted honey should be permitted to stand in the tank a few days so that the air and froth which go through the strainer may come slowly to the surface; then the clear honey may be drawn off from below and canned.

Honey House.—A beetight building or room equipped with running water and sewer connection is almost a necessity. Space in the basement will facilitate handling the product for storage. Extracted honey may be run through screens directly into tanks below for canning with minimum labor.

Removal of Comb Honey.—Comb honey is easier to remove than extracted honey in that less labor and equipment are required. The comb honey cappings must not be punctured, and as little smoke as possible should be used in robbing the bees. Many use no smoke at all but place a "honey board" under the full supers. The insects can then go out of the supers but cannot return on account of the bee escape passageway; at the end of 24 to 48 hours no bees will be left.

MARKETING THE CROP

Much remains to be learned about best methods of merchandising. The accumulation of a mass of data is, however, resulting from experiment and experience.

Containers for Honey and Methods of Selling.—Comb honey is sold in the section, just as it comes from the bees. Often a neat individual cardboard box container is used to keep it free from dust. Honey comb cannot be manufactured and filled, as many laymen suppose.

Extracted honey (liquid) is retailed in a great variety of containers, mostly of glass. The more attractive the appearance of the receptacle, the more readily the honey will sell.

The greater part of the extracted honey produced in California is sold by sample to wholesale buyers. The producers pour the honey (after it is strained into a tank and settled) into five-gallon cans, which go to market nailed two in a wooden case. Barrels and kegs, in which honey is wholesaled to buyers in some sections of the world, are not used in California.

The honey crop, if not large, may all be sold in the neighborhood where it is produced. The price should be in line with that of the product bottled by the regular honey dealers. Unfortunately many small sideline producers feel that anything received for their honey is just so much money found, because their cost of production is considered nothing. Men producing honey as a business suffer from the "price cutting" of the sideliner.

The United States Bureau of Agricultural Economics mails from Washington, D.C., upon request, its semi-monthly Honey Market

News Report covering the whole of the United States. The California State Department of Agriculture also renders this service. That part of the report pertaining to California for the first half of May, 1929, appears below:

"*Southern California.*—Following a long period of unfavorable weather, recent reports, especially from the Orange Belt, are somewhat more encouraging. Due to the recent warm weather, sunshiny days, and lack of heavy fog, the outlook for orange yield is now favorable where colonies are strong. Conditions in *Sage Sections* have also been better during the past two weeks. Black sage is in full bloom. Production will be very spotted, ranging from practically nothing in some sections to a fair crop in others. Nectar is also coming in from wild buckwheat, crowfoot, mustard, and a number of other ground flowers. Colonies are said to be inclined to swarm much more than usual, and beekeepers are finding swarming difficult to control this season. One beekeeper in San Diego County has already hived 210 swarms from his 420 colonies. Some sections, probably where colonies are weak, however, report very little swarming. Extracting of new crop sage has already started in a small way. The *Desert Slope of San Diego County* reports lots of bloom but little nectar, and prospects for a small crop only. In the *Imperial Valley* bees are building up slowly, and are several weeks behind last year. A little nectar has been coming in from arrowweed.

"Stocks of old crop honey are practically cleaned up. Few sales of White Orange by beekeepers reported at 10–10¼c per lb. Beeswax is lower in price, with sales reported at 28–30c per lb.

"*Central California.*—Crop prospects in the section where oranges are grown look fair where the bees have been taken care of.

"*Northern California.*—The dry weather in the *Sacramento Valley* with severe frosts at what should have been the peak of the flow, curtailed the spring flow to about 40 per cent of normal. Quality is reported fair. Mustard is now yielding. The thistle outlook is also poor because of the very dry weather. Bees are doing more now, due to warmer weather, but are still generally in poor condition, and some are finding it necessary to feed. This poor condition of the bees has put some shippers of bees behind in getting out orders, but they are now moving at a good rate. Beeswax of average grade has sold at 27–30c per lb."

BEE DISEASES AND PARASITES, WITH CONTROL MEASURES

Every keeper of bees must know something of the enemies to be dealt with.

Ants.—Ants of various kinds, especially the Argentine variety, habitually enter beehives and carry off honey, bee bread, and even young bees. If ants are troublesome, the hives (where a small number are concerned) can be placed upon stands, the legs of which are protected with oil, tanglefoot, or other material. The nests of ants, usually easy to locate, can be destroyed by the use of carbon bisulfide. A better method is to kill the ants with a poison syrup, exposed on sponges in closed cans or jars pierced with holes too small for bees to enter.

Birds.—Beekeepers sometimes accuse birds of killing many of their bees. The king bird or bee martin, certain other flycatchers, and the California jay, all have a bad reputation. Chickens may develop a liking for bees, especially when confined in the same yard with them and when supplied with nothing but grain feed.

Flies and Spiders.—Spiders capture bees both at the hive and in the field. The "hour glass" spider (*Latrodectus mactans* Fabr.) is particularly active at the hive; in the field, other species hide in cluster of flowers and catch worker bees visiting the blossoms. Robber flies (*Asilidae*) and occasionally dragon flies (*Odonata*) often catch workers and queens in the air, so that queen breeding is sometimes difficult where either of these insects abounds.

Mice.—Both the white-footed and the common house mouse sometimes enter the hive in winter, eat the combs, and disturb the bees during their winter rest. A coarse screen across the entrance during winter will eliminate this source of trouble. As mice and rats are also very destructive to combs, sections, foundation, etc., the storage house should be made proof against them.

Moths.—The larvae of two common species of bee moths (*Galleria mellonella* Linnaeus and *Achroia grissella* Fabr.) feed upon wax. Beekeepers know these as the "gray worms" which web up the combs. The larger of the two kinds is more common and better known. The adults, flying at night, enter the weak hives unchallenged by the bees and lay the eggs that hatch into destructive "worms." These insects cease to be a menace when the combs are properly stored and fumigated and when strong colonies of bees are maintained.

The Sage Worm (*Platyptilia marmarodactyla* Dyar).—This insect seriously damages the black and purple sages by destroying most of

the blossom buds in the buttons. Beekeepers in the sage region of southern California are all too familiar with the work of this caterpillar, called the "sage weevil," which tunnels through bud after bud in a button, sometimes destroying practically all. Two or three individuals may be found to a button. No practical measures can be offered toward control.

Skunks.—Skunks, being insect feeders by nature, may become enemies of bees. They are, however, of considerable value in keeping down rats, mice, grasshoppers, crickets, and other troublemakers, so that it may often be wise simply to protect the bees and leave the skunks free to war on pests. A skunk sometimes learns to scratch at the entrance of the hive and to catch the bees as they rush out in defense. Populous and spirited colonies with plenty of guards at the door appear to be favored, while mild-tempered colonies may be completely ignored. Small chunks of comb containing brood, poisoned with a small pinch of strychnine sulfate and placed about the apiary, will soon rid the premises of skunks if this becomes desirable.

Spray Poisoning.—Bees often suffer heavily by poisoning from sprays applied to blossoming fruit trees. A cover crop in blossom at the time of spraying may also involve loss of bees. Not only are the stomach poisons detrimental, being taken up from the blossoms, but the contact sprays while being applied kill large numbers of bees, especially if nectar and pollen gatherers are abundant at the same time. Bees, when thirsty, will even drink spray from any part of a plant. One can, however, largely remove this danger by supplying an abundance of good drinking water near the apiary. The problem of poisoning is rapidly becoming more serious as the practice of spraying increases. Because the use of arsenical sprays is open to criticism from other standpoints as well, a satisfactory replacement material is badly needed.

Termites.—These insects, often called "white ants," do not attack bees, but quickly riddle the hive bottoms in direct contact with the earth. Colonies of termites have been observed to eat up the bottom of a hive almost completely in one season. Redwood is much more nearly immune against attack than certain other woods in common use. Serious damage is also being done to timbers in building, etc., over much of the southwest.

Toads and Lizards.—The common garden toad and lizards may become enemies worthy of some attention on the part of the apiculturist. Their general feeding habits make them beneficial to agriculture, but when they prey on hive bees they become injurious. The large alligator lizards, *Gerrhontus* (two species), are often reported

to feed extensively on bees while hiding away under the hives. Toads are reported to snap up bees at the hive entrance, particularly at dusk.

Tramps.—Many beekeepers have to contend with thieving. If the colonies can be placed near the home of the beekeeper, or, in the case of an out-apiary, near some other dwelling house, such vandalism can be considerably reduced. Protective notices supplied by certain rural newspapers are also helpful.

Diseases.—The bee, like a human being, is subject to accident and disease. Poor food, unsanitary conditions, and exposure to cold or to disease-producing organisms bring about physiological conditions which may result in death. Among the diseases of bees may be mentioned American foulbrood, European foulbrood, bee paralysis, pickled brood, sac brood, dysentery, buckeye poisoning, and the like.

No elementary paper like the present one can adequately discuss the diseases of bees. Recourse should be had to the books listed at the end of this circular.

The beginner in beekeeping will soon recognize when his colonies are working normally and when they are not. Should numbers of dead larvae be found in the combs, the beginner should not try to diagnose the case himself, but should consult an expert, if possible the County Bee Inspector.

LAWS WHICH AFFECT THE BEEKEEPER

The beekeepers of Califorina worked, through their associations, for many years to have an up-to-date law passed to replace that of 1883. A State Inspector of Apiaries in the State Department of Agriculture enforces the law through the local County Agricultural Commissioners and deputies. Much satisfaction and some dissatisfaction at its enforcement are evidenced among the beemen. For the purpose of helping to familiarize the public with it, the California Apiary Inspection Act of 1927, and later amendments, are printed below.

CALIFORNIA APIARY INSPECTION ACT

Title of act.

Section 1. This act shall be known as the California apiary inspection act.

Definitions.

Sec. 2. The following terms used in this act shall be construed as follows:

Apiary shall be construed to mean any place where one or more colonies or nuclei of bees are kept.

Hive shall be construed to mean any receptacle or container made or prepared for the use of bees.

Appliance shall be construed to mean any implement or other device used in the manipulating of bees, or their brood, or containers thereof, which may be used in any apiary.

Disease shall be construed to mean American foul brood or anything affecting bees or their brood, which may cause an epidemic.

Inspector shall be construed to mean any person authorized to enforce the provisions of this act, as herein provided.

Enforcement of act.

SEC. 3. The state director of agriculture is hereby empowered to enforce all provisions of this act and to make, promulgate and enforce such rules and regulations as may be necessary to enforce the provisions of this act. The state director of agriculture shall have supervision over all enforcing officers. The neglect or refusal of any officer to carry out the orders and directions of the state director of agriculture in the enforcement of this act shall be deemed neglect of duty. The state director of agriculture is hereby authorized to appoint a state bee inspector and such deputies as may be necessary, who shall be qualified to perform the duties of inspectors under this act.

The county horticultural commissioner of each county of the state is hereby made ex officio state bee inspector, and may appoint, subject to the approval of the board of supervisors of such county, one or more county horticultural inspectors who shall be county inspectors of apiaries within the meaning of this act.

Quarantine regulations.

SEC. 4. The state director of agriculture is hereby authorized with the approval of the governor to establish, maintain and enforce such quarantine regulations as may be deemed necessary to protect the bee industry against contagion or infection by any bee disease by establishing such quarantine at the boundaries of the state or elsewhere within the state. He may make and enforce any and all such rules or regulations as may be necessary to prevent any bees, or their brood, used hives or appliances from passing over any quarantine line established and proclaimed pursuant to this act. All approvals by the governor given or made pursuant to this act shall be in writing and signed by the governor in duplicate and one copy thereof shall be filed in the office of the secretary of state and the other in the office of the director of agriculture before such approval shall take effect.

Temporary quarantine.

The state director of agriculture is hereby empowered to establish such temporary quarantine lines, for a period of fifteen (15) days, as may be deemed necessary in the opinion of the state bee inspector, to meet emergencies that may arise.

Certificate of freedom from disease required.

SEC. 5. It shall be unlawful to import into the State of California any bees or used appliances not accompanied by a certificate from a duly authorized inspector of apiaries or bee inspector, certifying that such bees or used appliances are free from disease as defined in this act, excepting used package bee cages returning empty.

Certification of bee food.

Any food prepared containing honey for combless package bees and queens shall be certified to as having been boiled not less than twenty minutes, certificate to accompany shipment.

Movement of bees within state.

Any person or persons who shall move bees from one county to another county within the state, or from one location within a county to another location within such county, shall first obtain from the county inspector of apiaries a certificate certifying that such bees are free from disease, and such inspector shall immediately mail a copy to the inspector of the county at destination, giving origin and destination of said bees, except where origin and destination are registered seasonal locations, only notice to inspector shall be required.

Duties of inspectors.

SEC. 6. The duties of a county inspector of apiaries shall be to cause an inspection to be made when he deems it necessary of any or every apiary within his jurisdiction, and if disease exists therein he shall so notify the owner or owners, person or persons in charge or in possession of said apiaries. Said notice may be served upon the person or persons or either of them having possession or owning such diseased apiaries by any inspector or by any person deputized by any inspector for that purpose, or by mail to last known address. All notices given by mail must be sent by registered letter. When the owners of any apiaries are not known, notice shall be posted at the apiaries in a conspicuous manner.

The inspector shall require such person or persons to eradicate such disease within a certain time to be specified in said notice.

Public nuisance.

Any and all such diseased apiaries are hereby declared a public nuisance, and whenever any such nuisance shall exist within his jurisdiction upon any property, the owner or owners of which cannot be found after diligent search within the county by the inspector; or upon the property of any owner or owners upon whom notice has been served as hereinbefore provided, and who shall refuse or neglect to abate the same within the time specified in such notice, it shall be the duty of the inspector to abate the same either by eradicating the disease or by destroying diseased hives together with the combs and bees therein.

European foul brood.

Upon inspection of any apiary, if European foul brood is found to exist to a serious extent in the opinion of the inspector, no certificate shall be issued for moving said bees; in lieu thereof a permit may be given to move such bees under the said inspector's supervision.

Movement of diseased bees prohibited.

SEC. 7. It shall be unlawful for any person owning or controlling bees within the state, which are known to be diseased, to move said bees, except upon written permission of the inspector for the purpose of eradication of said disease, to move said bees to a place known to the inspector to be safe. The inspector is hereby authorized in a summary manner to destroy or to treat any and all infected bees so moved within the state without such permit.

Immovable hives.

SEC. 8. The inspector shall order the owner or owners or other persons in charge of bees kept in box or other immovable or stationary-comb hives to transfer such bees to movable frame hives within a reasonable time to be specified in such order or notice, and in default of such transfer by the owner or owners or other persons in charge of such bees, the inspectors shall destroy or cause to be destroyed all such hives together with their contents.

Registration of apiaries.

SEC. 9. Every person within the State of California who shall be the owner or in possession of an apiary shall register with the county horticultural commissioner, giving the number of colonies and the location thereof and naming the owner thereof, within sixty (60) days after this act shall become effective, and on or before the first day of March of each year thereafter.

Unlawful to sell or move diseased bees without permit.

SEC. 10. It shall be unlawful to sell or offer for sale within the State of California or to transport or otherwise move any bees, or their brood, or hives or appliances infected with disease within the State of California except under written permission of a duly authorized bee inspector for the purpose of eradicating such disease.

Penalties.

SEC. 11. Any person who shall violate any of the provisions of this act or of any rule or regulation issued hereunder, or who shall conceal the fact that any disease exists among his bees or who shall expose to bees any infected bee products or hives or appliances or who shall fail to comply with any notice issued under the provisions of this act is guilty of a misdemeanor.

Statutes 1901, page 13, repealed.

SEC. 12. An act entitled "An act to promote the apicultural interests of the State of California by providing county inspectors of apiaries, and defining their duties, and providing for their compensation, and repealing the act entitled 'An act to authorize the boards of supervisors of the several counties of this state to appoint inspectors of apiaries, and provide for their compensation and defining their duties, and for the further protection of bee culture,' approved March 13, 1883," approved February 20, 1901, as amended, is hereby repealed.

AMENDMENT TO CALIFORNIA APIARY INSPECTION ACT, EFFECTIVE AUGUST 14, 1929

SECTION 1. Section 2 of an act entitled "An act to promote the apicultural interests of California by providing for the inspection and disposition of bees, their brood, hives and appliances that are or may be infected with disease, vesting the enforcement hereof in the state director of agriculture and the county horticultural commissioners, and defining their powers and duties hereunder, providing for the establishment of quarantines to prevent the introduction and spread of disease, declaring box hives and infected bees, their brood, hives and appliances to be a public nuisance and providing for the abatement thereof, providing for the registration of apiaries, prohibiting the

sale or removal of infected bees, their brood, hives and appliances without permit, providing penalties for the violation hereof, and repealing an act entitled 'An act to promote the apicultural interests of the State of California by providing county inspectors of apiaries, and defining their duties, and providing for their compensation, and repealing the act entitled "An act to authorize the boards of supervisors of the several counties of this state to appoint inspectors of apiaries, and provide for their compensation, and defining their duties, and for the further protection of bee culture, approved March 13, 1883," approved February 20, 1901, as amended,' approved May 31, 1927," is hereby amended to read as follows:

Sec. 2. The following terms used in this act shall be construed as follows:

Bees shall be construed to mean a colony or any portion thereof of honey-producing insects of the species *Apis mellifica* and shall include the adults, eggs, larvae, pupae, or other immature stages thereof, together with such materials as are deposited into hives by their adults excepting honey and beeswax in rendered form.

Apiary shall be construed to mean any place where one or more colonies or nuclei of bees are kept.

Hives shall be construed to mean any receptacle or container made or prepared for the use of bees or box or similar container taken possession of by bees.

Appliance shall be construed to mean any implement or other device used in the manipulating of bees, or their brood, or containers thereof, which may be used in any apiary.

Disease shall be construed to mean American foulbrood or anything affecting bees or their brood, which may cause an epidemic.

Inspectors shall be construed to mean any person authorized to enforce the provisions of this act, as herein provided.

Location shall be construed to mean the premises upon which an apiary is located.

SEC. 2. Section 5 of said act is hereby amended to read as follows:

SEC. 5. It shall be unlawful to import into the State of California any bees or used appliances not accompanied by a certificate from a duly authorized inspector of apiaries or bee inspector, certifying that such bees or used appliances are free from disease as defined in this act, excepting used package bee cages returning empty.

It shall be unlawful to place in any combless package of bees or queens offered for sale or shipment any food containing honey.

Any person, firm or corporation who shall move bees from one county to another county within the state, or from one location within a county to another location within such county, shall first obtain from the county inspector of apiaries a certificate certifying that such bees have been inspected and found free from disease, and the inspector issuing such certificate shall immediately mail a copy thereof to the county horticultural commissioner of the county at destination, if the same be other than the county of origin, stating on such certificate a definite point of origin and definite point of destination of said bees, excepting where origin and destination are registered seasonal locations only notice to inspectors shall be required.

SEC. 3. Section 7 of said act is hereby amended to read as follows:

SEC. 7. It shall be unlawful for any person owning or controlling bees within the state, which are known to be diseased, to move said bees, except

upon written permission of the inspector for the purpose of eradication of said disease, to move said bees to a place known to the inspector to be safe. The inspector is hereby authorized in a summary manner to destroy any and all infected bees so moved within the state without such permit.

PURE FOOD LAWS

The Federal Food and Drugs Act has been of greatest benefit to beekeeping. Its essential feature is that the label shall tell the truth about the contents of the package and give the net weight of the contents. Unsuccessful efforts have been made repeatedly to nullify parts of this law to permit the use of corn syrup in honeys without declaration.

HONEY INFORMATION

Only fragmentary information can be supplied here from the vast amount known concerning honey.

California Honeys.—Any discussion of California honeys involves mention of the nectar producing plants. As a rule the honey from a given plant has a specific flavor and a rather definite color and "body" or consistency. The color is perhaps the most variable character, and in some plants varies more than with others. For example, alfalfa honey from the lowlands of California is usually near amber color, while from regions of higher altitude nectar from this same plant produces honey almost water white in grade. Apparently more variations in nectar flow and color of honey are produced by alfalfa grown under different conditions than by any other nectar plant in the United States.

The two honeys largely responsible for California's reputation in bee products are those produced from sage and orange, with which the major part of the export honey trade has been built up. The fact is somewhat unfortunate because of the depressing effect upon other honeys nearly or quite as well flavored. Sage honey, which comes mainly from three species (the black, purple, and white sages), is almost water-white in color and blandly mint in flavor. It granulates only after a long time—another reason for its desirability as a bottling and blending honey. "Orange" honey is made largely from the orange blossoms (navel, Valencia), although the other citrus blossoms (lemon, tangerine, grapefruit, etc.) contribute slightly to the total. This honey possesses a very light color tending toward yellow, although at times almost white. It granulates rather quickly. Thorough ripening of orange honey before extraction greatly reduces the tendency to ferment.

Star thistle honey is rapidly making a name for itself because of its superior qualities of greenish lemon color, very heavy body, and delightfully pungent, super-sweetish taste. On first sampling this honey, one makes a repeated effort to identify the flavor as familiar. If the plant itself had not so bad a name with grain growers, we should be more enthusiastic and dwell at greater length upon the fineness of its honey. Stockmen are, however, becoming tolerant of the star thistle because it produces a large amount of forage, eaten by stock with relish before the spiny blossoms appear in late June and again in the autumn after rains have softened the old stalks.

Honey from the wild buckwheat (*Eriogonum fasciculatum* Benth.) common in southern California is of light amber color and distinctly agreeable flavor; it, too, is subject to granulation after extraction. This is easily the principal honey-producing plant for many apiaries within range of it. Other species of buckwheat, much more widely distributed, are of minor importance as honey producers. Wild alfalfa or deerweed (*Lotus scoparius* Ottley) honey should be mentioned. The plant, though of very wide distribution, is erratic as a honey producer, being considered important only in certain localities. Beekeepers report wild alfalfa honey as being white, light amber, or amber in color with, at times, a characteristic greenish tinge.

Christmas berry or toyon (*Photinia arbutifolia* Lindl.) affords a thick distinctively flavored, amber honey, which candies to coarse granules within two or three months after extraction. Surplus crops are reported from many points in the state. It abounds in parts of the Coast ranges from Napa County to Humboldt County, along the lower slopes of the Sierra Nevada, and in southern California.

Several other honeys are at times common enough on the market to be known by name. Among these might be mentioned blue curl, carpet grass, fire weed, honey dew, horehound, mesquite or algaroba, Nevada safe (alfalfa), sweet clover, and white clover. Seldom can one buy any *particular* honey with absolutely constant characteristics. Not only does the color undergo actual annual variation, but honey from other sources is stored in the same comb by the bees. Many bottlers make a practice of blending their honeys in order to supply a product fairly constant as to color.

Granulated Honey.—Honeys high in dextrose are prone to granulation. Tables 2 and 3 give sugar content of several honeys. Some honeys, such as those from alfalfa, blue curl, iceplant, and mustard, granulate ("sugar" or "candy") quickly after being exposed to the air by extraction. Such honeys may be allowed to granulate in large cans, which are later cut open, the semisolid mass is then cut into

one-pound bricks and wrapped in paraffin paper. *Honey butter* is a creamy, granulated honey, prepared by stirring or whipping the granulated honey, and sold like peanut butter. The process breaks up the sugar particles very finely and reduces the color several tints. Granulation is hastened by storage with sharp temperature changes, especially if the honey is placed under refrigeration each night. Conversely, the liquid condition may be maintained best by exposure to heat: for instance, a honey which ordinarily granulates quickly may never "sugar" if stored in the attic under a roof exposed to the sun. Grocers commonly keep their stocks of honey on the warmer top shelves of their stores.

Granulated honey may be restored to its liquid state without impairing its flavor or color by exposure to a temperature of 120–140° F for 24 to 48 hours. It should never be warmed directly over a stove or flame, for such intense heat injures the flavor and other properties. A water bath or hot oven of known temperature should be used. As beeswax melts at about 140° F, granulated comb honey must be warmed with extreme care to avoid destruction of the cells.

Honey and Refined Sugars.—Since antiquity, honey has been an important item in the food of man. Until comparatively recent times, it was probably the only concentrated sugar used by the human race. Not until the fifteenth or sixteenth centuries was sugar cane brought to Europe by crusaders; the first refined cane sugar was made in 1792 by Antonio Mendex. Margaraff, a member of the Berlin Academy of Science, discovered beet sugar in 1747, and Archard first extracted it in 1800. Today the use of cane and beet sugars is so common that few persons realize the novelty of refined sugars in the history of mankind. Honey, on account of the definite limitation for quantity production, has come to occupy a very secondary place among the many concentrated sweets now consumed, and yet nothing in the world can take its place for aromatic flavor and wholesome sweetness. From the chemical and physiological standpoints, its value as an item of diet is high.

Tables 2 and 3 give the general percentage composition and sugar contents of several American honeys. The data for both tables were adapted from Bulletin 110, U. S. Bureau of Chemistry. The granulation of honey depends upon the proportions of dextrose and levulose.

Honey Diastase Injured by Heat.—Recent complaints from Germany concerning the overheating of American honeys have stimulated investigational work here. Germany classifies as adulterated, any honey heated to such an extent as to weaken seriously or destroy the diastase activity, and specifies that it must be sold at a low price for

cooking purposes. Honey (star thistle) produced in the University of California apiary at Davis has been subjected to heating (70° to 212° F) for 24 hours and then tested for diastase acitivity on a starch solution. Temperatures up to 120° had but little effect on the diastase of this honey, but increasingly higher temperatures rapidly reduced its activity, which was completely destroyed in honey exposed to 165° F for 24 hours. Some German honeys are reported to be seriously injured at 104° F. Also, different kinds of honeys (raw) show a marked variation in diastase activity. A simple picture of the effect of heating honey is shown in graphic form in figure 4.

TABLE 2

AVERAGE CONSTITUENTS OF SEVERAL HONEYS

Determination	American dextrorotatory honeys, 7 samples			American levorotatory honeys, 92 samples		
	Average per cent	Maximum per cent	Minimum per cent	Average per cent	Maximum per cent	Minimum per cent
Water	16.09	17.80	13.56	17.70	26.88	12.42
Invert sugar (levulose and dextrose)	66.96	71.69	64.84	74.98	83.38	62.23
Sucrose	3.01	5.28	0.61	1.90	10.01	00.00
Ash	0.81	1.29	0.29	0.18	0.90	0.03
Dextrin	9.70	12.95	6.02	1.51	7.58	0.04
Undetermined total	3.43	4.95	1.56	3.73	7.45	0.04

TABLE 3

INVERT SUGAR CONTENT OF VARIOUS HONEYS

Source of honey	Dextrose (grape sugar)	Levulose (fruit sugar)
	per cent	*per cent*
Alfalfa	36.85	40.24
Alsike clover	36.06	40.95
Apple	31.67	42.00
Aster	33.93	41.31
Basswood	36.05	39.27
Buckwheat	36.75	40.29
Catclaw	38.21	40.81
Cotton	36.19	39.42
Dandelion	35.64	41.50
Eucalyptus	38.72	38.65
Goldenrod	34.45	37.85
Locust	35.98	40.35
Mesquite	38.04	41.03
Raspberry	33.57	41.34
Sage	24.35	48.75
Sumac	33.72	37.61
Sweet clover	36.78	39.39
Tupelo	24.73	48.61
White clover	34.96	40.24
Wild buckwheat	35.39	41.36

The diastase activity of several raw honeys has been found to correspond closely with the pollen content. From the standpoint of "overheating" it should be mentioned that honeys high in acidity react to overheating tests, while others low in acid do not so react after identical exposure. Very little is yet known about honey acids.

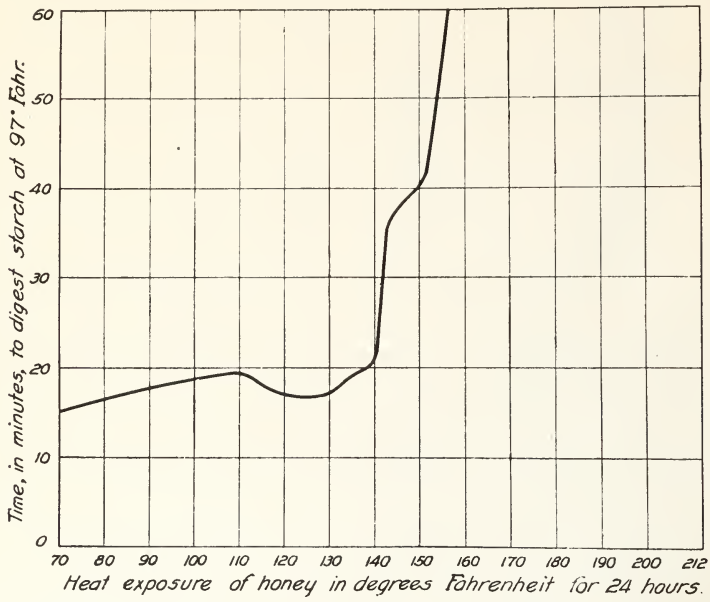

Fig. 4.—Excessive heat kills the hydrolytic power of diastase. Starch cannot be changed to sugar by the inactivated diastase from overheated honey.

LOCATIONS BEST SUITED TO BEEKEEPING

California Weather and its Effect on Bees.—No other state in the union has such variation in climatic conditions as does California, which extends over a distance of about 850 miles from northwest to southeast, and includes within its borders the highest, lowest, and driest places in the United States. These extreme differences have affected bees, which are always very sensitive to surrounding conditions. In general, however, the temperature in the valleys and low hills where many of the colonies are kept shows little variation. Along the coast the difference in the high and low means may be but a few degrees. Many places never experience a freezing temperature. Other things being equal, bees thrive best under conditions where both night and day temperatures are relatively high. Table 4 gives temperatures at Davis, California, as typical of one section, and the figures can be used only by way of comparison with conditions in other parts of the state.

TABLE 4

TEMPERATURES RECORDED AT DAVIS, CALIFORNIA

Month	Maximum and minimum means for 1928		Highest and lowest temperatures during a period of 19 years	
	Deg. Fahr.	*Deg. Fahr.*	*Deg. Fahr.*	*Deg. Fahr.*
January	52	37	75	16
February	62 24	36 8	84	21
March	66 22	43 71	84	28
April	71 7	41 8	91	25
May	86 42	47 93	108	32
June	92	51 9	108	49
July	92 16	51 8	116	52 6
August	95 87	49 45	112	37
September	91 73	48 17	107	35
October	78 35	44 51	98	27
November	62 83	38 16	83	23
December	51 7	32 5	71	17

Attention is called to the value of scale-hive records correlated with weather conditions and blossoming nectar plants. Mr. A. Dickenson of St. Helena has very excellent records for his location, covering many years. The graph, figure 5, was prepared from his record for one year. The gathering together of similar records no doubt in the hands of individual beekeepers over the state would be of decided interest and scientific value. A calendar of operation can be prepared from such records because the comparative changes in the flora, etc., through the year are relatively constant. Despite fat and lean years in surplus stores, available nectar from given plants will come at roughly the same time each year; and one familiar with any location can predict its honey crop within certain limitations.

A practical method of increasing the value of the records, so that they may be used in a calendar of operations for the season, is to plot them in the form of a graph like the specimens given in figures 5 and 6, which picture conditions very clearly. The interval shown may be so greatly reduced that the record for the whole year may be placed on one large sheet of paper, which can then be tacked up on the wall for immediate reference in comparing successive seasons.

Honey Regions.—Earlier workers have divided California, with reference to honey production, into a number of regions, based largely upon the varying climatic factors with the resulting diversity in vegetation, both native and introduced. Richter[4] has described twelve districts, while Benton[5] recognized four with many minor divisions. Neither of these works describes the subject to complete satisfaction.

[4] Richter, M. C. Honey plants of California. California Agr. Exp. Sta. Bul. 217:971–1040. 1911.

[5] California College of Agriculture Extension Course in Apiculture.

Roughtly, certain justifiable regions are the coastal belt from Monterey Bay to Mexico; Imperial and other low inland valleys of southern California; San Joaquin Valley; Sacramento Valley; transmountain plateaus east of the Sierra Nevada; and the coastal redwood belt from Santa Cruz County northward to Oregon. Some of these regions can be much subdivided according to flora and nectar secretion.

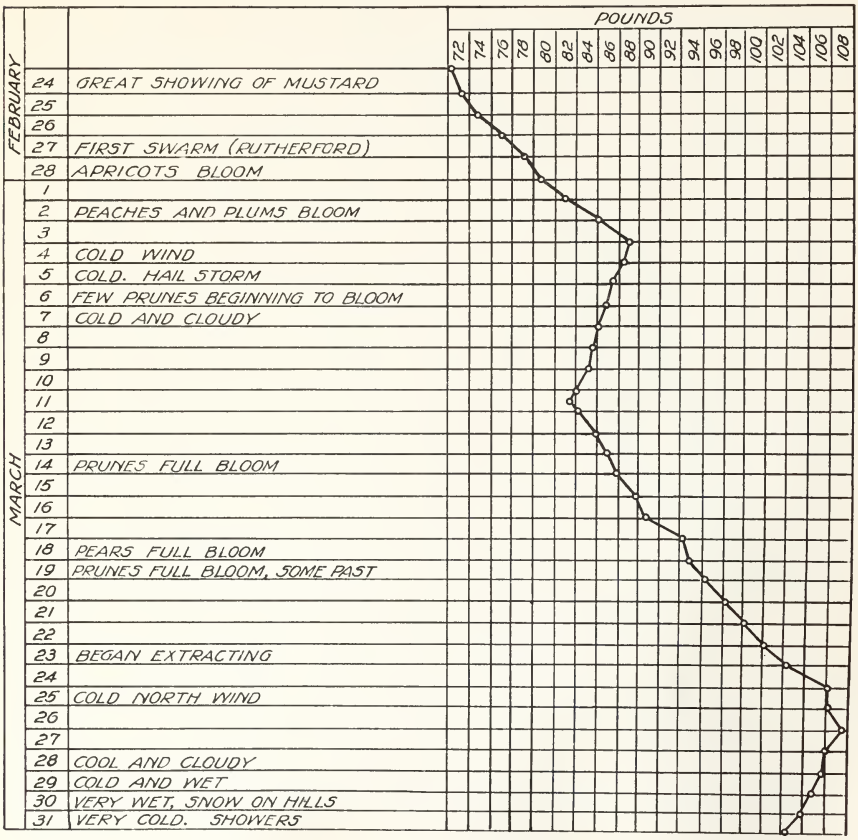

Fig. 5.—A graph showing increase in colony weight correlated with weather conditions and the flora. Data from St. Helena, California.

The life zones of California as established by Merriam, Jepson, Abrams, Grinnell, and other workers, afford a guide to the establishing of honey regions. California possesses an unusual diversity of forms of plant life. Some nectar plants are distributed almost statewide, but some which are good producers in a number of regions in one particular district may be so influenced by climate, altitude, soil, or other factors as to yield little, if any, nectar.

Honey and Pollen Plants.—The six principal nectar plants (or groups of plants) of California, according to the observations of the writer, are the true sages (*Salvia*), orange, alfalfa, star thistle, wild buckwheats, and Christmas berry (Toyon); three of these are indigenous, the others have been introduced. A rough distribution map (fig. 7) shows where these plants are of decided importance as a source of nectar. Many other nectar plants are fairly significant, and locally

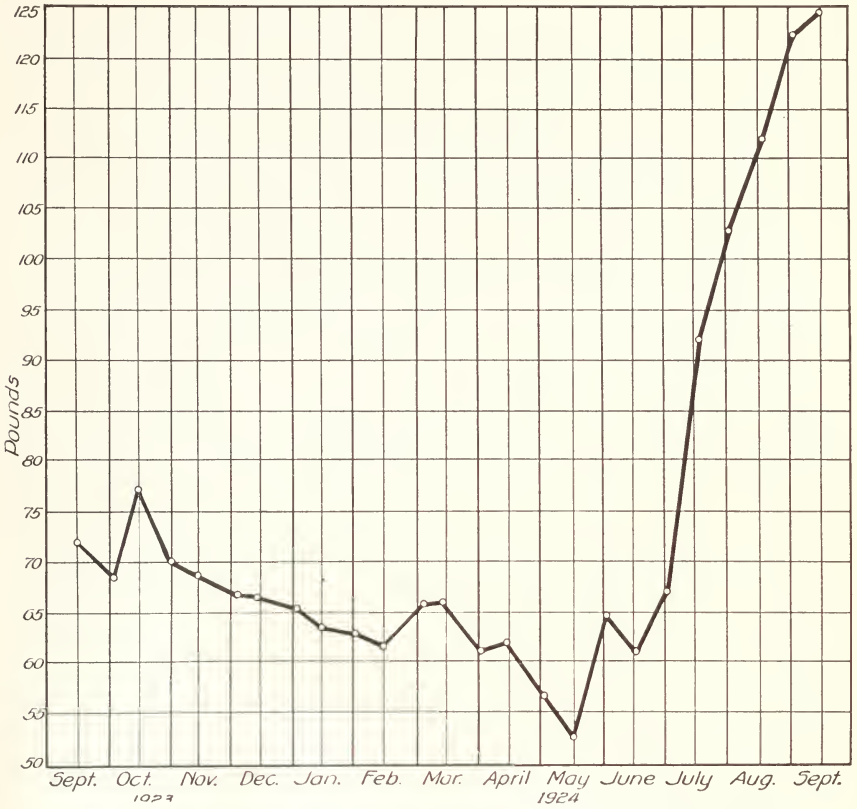

Fig. 6.—A graph showing colony weight through the year at Davis.

any one of a dozen not mentioned above may constitute the chief source of nectar. The importance of having sufficient pollen producing plants must not be overlooked. Richter, while listing 168 species and varieties of nectar and pollen plants, omits many others. Anything but a brief discussion of the California nectar plants would require much more space than can be given here, but the books on honey plants mentioned in the bibliography at the end of this circular give the names and pictures of many California honey plants and might well be in the hands of every beekeeper.

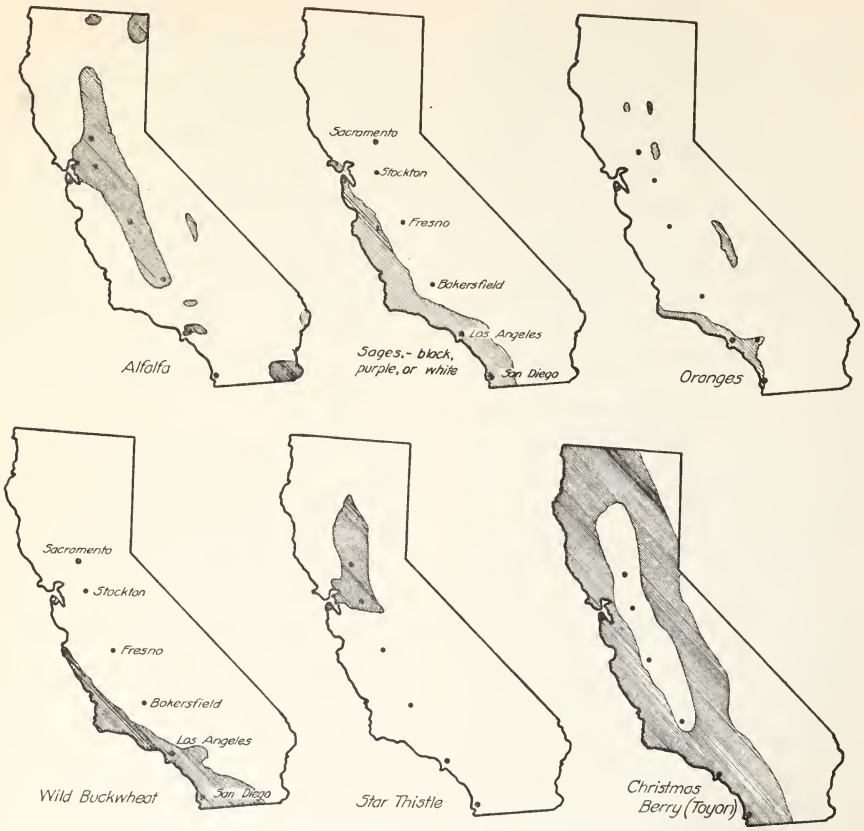

Fig. 7.—Certain honey plants of California, with distribution.

An incomplete list of nectar and pollen plants follows. As local duplication makes many common names unreliable, the generic name appears in most cases. Yielding dates, when indicated, are only approximate.

Acacias (25 or more)—*Acacia*
Alder—*Alnus*—spring
Alfalfa—*Medicago*—May–September
Alfilaree—*Erodium*—spring
Alsike clover—*Trifolium*—summer
Amsinckia (called leather breeches and fire weed)—March–April
Apple—*Malus*—April–May
Asparagus—*Asparagus*—May–June
Basswood—*Tilia*
Beans (several)—August
Bear clover—*Chamaebatia*—July–August
Blackberry—*Rubus*
Black locust—*Robinia*—April
Black sage—*Salvia*—May–June
Blue curls—*Trichostema*—August–September
Bottle tree—*Sterculia*—July
Box elder—*Acer*
Buck horn—*Plantago*—summer
Buckthorn—*Ceanothus*—March
Buckwheat—*Eriogonum*—July–August
Burning bush—*Euonymus*
Bur clover—*Medicago*—April

Button bush—*Cephalanthus*—July
Button willow—*Cephalanthus*—July
Cactus plants (many species)
California beeplant—*Scrophularia*—May–July
California buckeye—*Aesculus*—May–June
California pennyroyal—*Mentha*
Calycanthus—*Calycanthus*
Cantaloupes—*Cucumis*—summer
Carpet grass—*Lippia*—May–September
Cascara—*Rhamnus*—May–June
Catnip—*Nepeta*
Catclaw—*Acacia*—April–May
Century plant—*Agave*—summer
Chaparral broom—*Baccharis*
Chia sage—*Salvia*—May
Chickory—*Chichorium*
Chickweeds—*Stellaria*—February–March
Christmas berry—*Photinia*
Choke cherry—*Prunus*
Clematis—*Clematis*
Coffee berry—*Rhamnus*—May
Colorado River hemp—*Sesbania*
Coreopsis—*Coreopsis*
Corn—*Zea*—July–August
Cotton—*Gossypium*—July–August
Creosote bush—*Larrea*—spring
Crimson sage—*Salvia*—May–June
Dandelion—*Taraxacum*—spring
Date palm—*Phoenix*
Deciduous fruits (apples and plums especially)—March–April
Deer weed—*Lotus*—May–July
Desert thorn—*Lycium*—spring
Dodder—*Cuscuta*
Dogbane—*Apocynum*—summer and fall
Doveweed—*Eremocarpus*—August–September
Elm—*Ulmus*—February–March
Figworts—*Scrophularia*—May–June
Filaree—*Erodium*—March–April
Fire weed or great willow herb—*Epilobium* (often confused with *Amsinckia*)—July–September
Garden flowers
Germander—*Teucrium*
Globe artichoke—*Cynara*—June
Goldenrod—*Solidago*—fall
Hard tack—*Cercocarpus*—May–April
Heather—*Calluna*
Hedge nettle—*Stachys*
Hemp—*Galeopsis*
Honey dew from plant and animal sources
Honey locust—*Gleditsia*
Honeysuckles—*Lonicera*
Horehound—*Marrubium*
Huckelberry—*Vaccinium*
Iceplant—*Mesembryanthemum*
Jackass clover—*Wislizenia*—July–August
Jacob's ladder—*Polemonium*
Jagger weed—*Centromadia*
Jerusalem thorn—*Parkinsonia*—June
Kale (gone wild)—March–April
Knot weed—*Polygonum*
Loco-weed—*Astragalus*
Loganberry—*Rubus*
Loquat—*Eriobotrya*—January–February
Lotus—*Lotus*
Madrone—*Arbutus*—April
Magnolia—*Magnolia*
Manzanitas (25)—*Manzanita*—December–February
Maples—*Acer*—April
Mat grass—*Lippia*—May–August
Meadow foam—*Limnanthes*—March–April
Mesquite—*Prosopis*
Milkweeds—*Asclepias*—July–August
Mistletoe—*Phorandendron*
Mountain azalea—*Rhodondendron*
Mountain dogwood—*Cornus*—summer
Mountain lilacs (several)—*Ceanothus*—March–May
Mountain mahogany—*Cercocarpus*—March–April
Mountain misery—*Chamaebatia*—July–August
Mullein—*Verbascum*
Mule fat—*Baccharis*
Musk clover—*Erodium*
Mustang mint—*Monardella*
Mustards (several)—*Brassica*—spring

Myrtle—*Melaleuca*
Napa thistle—*Centaurea*
Oaks—*Quercus*
Olive—*Olea*
Onions—*Allium*—summer
Orange—*Citrus*—April
Palm trees
Palo verde—*Cercidium*
Passion flower—summer
Pear—*Pyrus*—March–April
Pennyroyal (Western)—*Monardella*
Pepper tree—*Schinus*
Persimmon—*Diospyrus*
Pin clover—*Erodium*
Pine honeydew
Poinsettia—*Euphorbia*
Poison oak—*Rhus*
Privet—*Lingustrum*
Purple sage—*Salvia*—May–June
Rabbit brush—*Chrysothamnus*—August–October
Raspberry—*Rubus*
Redberry—*Rhamnus*
Redbud—*Cercis*—March–April
Salal—*Gaultheria*
Scarlet sage—*Salvia*
Screw bean—*Prosopis*—May
Scrophularia—May–June
Serviceberry—*Amelanchier*
Sheep's tansy—*Phacelia*—April–May
Smartweed—*Polygonum*
Snowberry—*Symphoricarpos*
Soap plant—*Chlorogalum*—May–June
Spanish clover—*Lotus*—summer
Spanish needle—*Bidens*—fall
Spearmint—*Mentha*
Spike weed—*Centromadia*—July–August
Spiny clotbur—*Xanthium*
Squash—*Cucurbita*
Storksbill—*Erodium*—spring
Strawberry—*Fragaria*
Sudan grass—*Andropogon*
Sunflowers—*Helianthus*
Sumacs—*Rhus*
Sweet clovers—*Melilotus*—summer and fall
Tamarisk (Athel especially)—*Tamarix*
Tar weeds (6 or more)—*Hemizonia*—summer and fall
Teasel—*Dipsacus*
Thistles (several)
Thistle sage—*Salvia*
Tocalote—*Centaurea*
Tree of heaven—*Ailanthus*
Trumpet vine—*Tecoma*
Tule mint—*Mentha*
Tulip tree—*Liriodendron*—May
Turkey mullein—*Eremocarpus*—August–September
Varnish tree—*Ailanthus*—June–July
Vetches—*Vicia*
Watermelon—*Citrullus*
White clover—*Trifolium*—summer
White sage—*Salvia*—June
Wild alfalfa—*Lotus*—April–July
Wild hollyhock—*Sidalcea*—January–May
Wild plum—*Prunus*—spring
Wild radish—*Raphanus*
Willows—*Salix*—spring
Woolly blue curls—*Trichostema*
Yerba Santa—*Eriodictyon*—May–June
Yucca—*Yucca*

The importance of the above mentioned plants depends largely upon their local abundance so that in given areas any one of them could be the *chief* source of nectar or pollen. For the state as a whole, however, many of them merit but minor consideration. Several other plants will add materially to the nectar supply when they become abundant.

Cultivation of Nectar Plants.—Beginners in beekeeping often suppose that special crops may, with profit, be planted as a supply of pollen and nectar. Bees must, however, visit hundreds or even

thousands of blossoms to obtain the nectar for a single pound of honey, and numerous experiments by individual beekeepers and by experiment stations have shown that planting of crops for honey yield alone is uneconomical. However, a crop used for some other purpose (stock feed, cover crops, seed production) and productive of nectar is more desirable than one that does not afford bee pasturage. Alfalfa, sweet clover, sheep's tansy, vetch, and cotton are to be mentioned in this connection. Many ornamental trees and shrubs yield nectar during their blooming periods, and fruit trees and berry plants supply it generously in early spring. California privet, willow, eucalyptus, black locust, "tulip poplar," catalpa, umbrella China, basswood, Jerusalem thorn, acacias, Japanese quince, myrtle, olive, "silk oak," varnish tree, and many other useful or beautiful plants add to the available nectar and pollen supply. The late blossoming eucalyptus are especially valuable for a fair quantity of nectar in the interior valleys. The State Highway Commission is increasing the nectar flora by using suitable species along our highways.

QUEEN REARING

Prolific Queens Important.—The success of a colony so largely depends upon the presence of a good queen, that emphasis is here placed upon the importance of learning to rear queens at home. Mother bees raised in the yard and put to work without the necessity of being confined and abused by shipping usually give best results. Some few successful beekeepers will not wish, however, to rear even the small number of queens they require, and in such cases may purchase them from any one of the large number of commercial queen rearing men in the state. It is advisable to purchase mated untested stock because these, though less expensive, will usually prove as good as the tested.

Queen bees differ from workers only in the development of the sex organs and sex characteristics. The eggs from which a queen and a worker come are exactly alike. The young larvae are also alike for the first one or two days of their existence and receive from the bees the same care and food. After this time the larvae destined for workers are fed differently from those intended for queens. In nature the bees build queen cups and cells in which to raise the mothers. In artificial queen raising the beekeeper supplies these cups and puts into each a very young larva and a small amount of royal jelly—simply imitating nature. The presence of these cells containing young larvae

induces the bees to finish them into ripe queen cells, from each of which emerges a virgin queen.

The bees (a good strong colony) during a nectar flow will care for many of these artificial cups at the same time, so that many ripe (or sealed) queen cells may be procured in succession. The cells, once ripe, may be removed and allowed to emerge in a nucleus. The young queen will fly out and mate when she becomes old enough.

Queens for Sale.—The queen raisers advertise tested, untested, and virgin queens. The tested queens have been allowed to breed and kept long enough to enable the characteristics of their nature to be determined. The untested queens have been mated but not tested out. The virgins are those very newly emerged queens which have not even mated.

One Method of Rearing.—The development of a queen bee requires fifteen to sixteen days, including egg, larval, and pupal stages. The eggs hatch in three days. The larva is fed five to six days; and the pupa (or sealed cell) requires seven days to reach the age of emergence.

Most producers of queen bees in the United States use the method followed by Doolittle in his pioneering work along this line. For the sake of brevity and clearness this Doolittle method alone will be discussed. Artificial wax cups are used either with or without wooden cell bases. When used without the base they are attached to a wood strip by melted beeswax. The wood base is desirable, however, because the cells can be handled by the base and held just where wanted by a tack projecting from the bottom of it. The cells are hung from the lower edge of a wooden bar or bars just long enough to slip lengthwise into a regular brood frame, where they are nailed.

Of the numerous variations in the treatment of colonies used in queen rearing only one, not necessarily the best under all given conditions, will be described here.

Royal jelly, necessary before a start is made with these operations, is found in the bottom of a queen cell as a thick substance looking very much like ordinary thick white library paste.

The plan selected for discussion here is one used by many men for rearing queens in the same colony over a very long period. A strong colony is necessary to start with, and a nectar flow is assumed. The comb where the queen is found is put in an empty hive body, which is then placed on the site of the selected colony and is usually filled with empty drawn combs and covered with a queen excluder. If the weather is warm, an empty set of extracting combs may be placed over the excluder. The original hive with the brood is placed on top of this empty body. Twenty-four hours later the bees are given a set

of cell cups containing very young larvae in a small amount of royal jelly. Many men feed a little sugar syrup at this time by sprinkling it over the top of the colony. The bees will usually go to work on the queen cups and mature most of them. When the weather is warm, cells can be built indefinitely above the same colony by lifting the brood into the upper chamber as fast as it is sealed in the brood nest. In weather cold enough to chill the brood, the empty comb body over the queen excluder had best be left out, but results are better at a temperature warm enough for its use. A very strong colony is necessary in any case.

After the day-old (or less) larvae are placed in the top of the breeding colony, four or five days will elapse before the sealing of the finished cells, which may then be taken out and placed at will in other colonies or an incubator. Most breeders leave the cells to the care of the first bees until the evening of the ninth day, then cage them in protectors or give them directly to nuclei where they are to be mated.

Great care must always be used in handling queen cells, for jarring may dislodge the immature queen from her position and so produce a deformed adult. The longer the cells are left undisturbed, the less the danger of injury. Bees should never be shaken from a frame containing queen cells; they should be smoked and brushed off.

Ripe queen cells placed in nuclei or colonies which have been queenless for twelve hours are almost always safe, but if they are placed in colonies or nuclei as the old queens are removed they will often need protection. Because bees tear down queen cells at the side, a protector should be slipped around the cell, the end being left open so the queen can still emerge.

The transfer of young larvae (or eggs) to the cell cups may be done with a toothpick. After a little royal jelly has been placed in the top of each cup, the larvae are transferred from the brood cells of the queen from which the breeding is to be done. Several cups are used, perhaps twelve to a bar and three bars. The larvae must be transferred when warm or in a warm room to avoid chilling, one larva being placed in each cup. Specially prepared tools for transferring are on the market.

Mating.—After emerging, the virgin queens will have to fly out for copulation with a drone, which must be of good character to insure good progeny. The queens are usually allowed to mate from small hives (nuclei) or from compartment hives. They are left in the nuclei until they have begun to lay freely; then they are introduced wherever wanted.

Queen cups, frame bars, etc., cannot well be described without illustrations. The purchase of a special treatise on queen rearing is advised for those who care to know more than can be outlined here. Books on this subject are given in the bibliography.

Introducing Queens.—A queen must be placed in the desired colony with special care to insure her hospitable reception by the other bees. The method of introduction most generally employed is a small cage in which the queen is confined with a half dozen or so workers from her mating nucleus. The hive to be requeened is opened and the old queen killed, after which the cage plugged at one end with candy and containing the new queen is put in between the middle frames at the top of the hive. The queen is automatically liberated after several hours by the bees eating out the queen candy.

Queen cages, also used for sending queens through the mail, may be purchased for a few cents each. A printed card accompanying each cage gives complete directions for introduction. Queen candy is made by mixing powdered sugar with either honey[6] or invert sugar into a stiff dough.

BUSINESS ASPECTS

Agricultural production, as far as the farmer is concerned, is generally far removed from the business of disposal to the consumer. Its commercial side is often neglected. With the present progress in centralized and specialized production, closer inspection and reduction of cost are necessary.

Products of the Apiary.—The profits and benefits of beekeeping are many. In years past the honeybee gave man his only concentrated sweet, his best drink, and his light in the form of wax candles; the pure pleasure gained by thousands of amateur beekeepers the world over from the mere tending of the hives, is in itself no small item. Today the bee has lost some of its importance, but for the pollination of fruit it has gained with the concentration of planting and the reduction of the native forests. Main products and by-products may be mentioned in considering the products of the apiary; the inclusion of a certain product within one or the other class depends somewhat upon the aims of the individual beekeeper. In a case where the more effective production of fruit or seed is regarded as the main purpose for which bees are kept, the honey stored and harvested becomes purely a by-product. Ordinarily, however, the main products are

[6] Such use of honey is unlawful in California when the queens are offered for sale.

honey (comb, chunk, or extracted), wax, bees, and queens. A great majority of the persons engaged in the keeping of bees intend to produce only honey for table use, and most of these specialize in comb honey. The sale of live bees (in packages) and queens is becoming a major objective of many southern beekeepers where early production is possible for shipment to northern localities.

The annual production of honey and wax in the United States makes apiculture a profitable minor industry. Although beekeeping, from its very nature, can never become one of the leading agricultural pursuits, the producers' profit on the California honey crop alone (that part which is sold) is estimated at considerably over $1,000,000 annually. Exports of honey from the United States in 1928 totalled 9,943,615 pounds.

Especially should it be noted that the keeping of bees impoverishes nothing, the bees gathering products which would otherwise go to waste. The amount of ungathered nectar in most localities is still very great, because bees are not present for storing it during the very short time that it is available. The new beekeeper should realize, however, that the bright side of the picture is not the only one.

By-Products.—The by-products harvested from apiary endeavors include propolis, honey vinegar, pollen, formic acid, and (in Europe) mead or honey wine. A word regarding the source and uses of the by-products may be of value. Propolis is known to every beekeeper under its commercial name of "bee glue." Its source has been questioned recently, but ordinarily it is supposed to be collected by the bees from the waxy bud scales and other parts of various trees, especially poplars, willows, and eucalypts. In any case, the bees bring it in from the field in much the same manner as pollen. Their uses for it are many; with it the frames are cemented in place, the tops and bottoms are glued fast to the hive body, the hive entrance is contracted, and cracks are stopped against robbers and weather; the dead bodies of mice or lizards killed within a hive have been reported to be completely encased in propolis. Man uses "bee glue" in a number of ways. Because it liberates a very pleasant characteristic odor while burning it sometimes serves as a sort of incense, especially for church rites. Much propolis is said to be used in Europe and elsewhere for this purpose, along with beeswax candles. Pollen, required for rearing young bees, is at times removed from the hive for use in laboratories. According to old medical writings, formic acid from the stings has an enviable record in the treatment of rheumatism and related ailments. Certain enthusiasts for honey and its curative properties, physicians as well as laymen, are, to say the least, very zealous in

proclaiming their ideas. Mead[7] is the well-known European honey wine in common use for many years. Honey vinegar is a most delicious by-product. It is, when carefully made, a vinegar of high acid content with a delicious honey flavor. Many epicures are so positive of its superiority to every other vinegar that they insist upon its exclusive use in the preparation of their foods.

Costs and Returns.—The cost of production in agriculture is often dangerously near the sum received by the farmer for the product. Indeed, the selling price sometimes does not cover the total cost of production. If men on the farm were to figure in equitable wages for their labor when compared with most other commercial enterprises, the money received would usually not pay the cost. Evidently the farmer, his wife, and children, even in this fair land of ours, are not being well paid for their work.

As honey is often produced at just about the producer's selling (or better, receiving) price, one naturally wonders how the beekeepers are able to remain in honey production. Many of them cannot continue without income from other lines of effort, and even then change in occupation is necessary for many.

Most farmers are rather poor bookkeepers, and the actual cost of producing foodstuffs on the farm are hard to calculate. Few producers know just how much in time and money is put into their business. Very many of them enjoy home ownership with low water and certain other household costs. Such independence is not, of course, all roses, because taxes, interest, and upkeep are rather sizable items; but even so, a renter pays these costs in addition to a more or less fair return to the owner.

A. K. Whidden of southern California compiles careful accounts. He has produced honey from many colonies in various locations through good years and bad, so that his figures are very valuable from many viewpoints. The accompanying graphs tell the story much more clearly than pages of words could do. Figure 9 shows the cost of producing honey in southern California from 1911 to 1927. The average cost for nine years is seen to be 7⅔ cents per pound. During certain seasons the cost is very high, for example in 1911, 1912, and 1913, years of near or total crop failure from reasons beyond control. Normal operating expenses must of course be maintained during such years with bees as well as other farm animals. The average price received by producers for extracted honey over a period of years is slightly less than 8 cents a pound.

[7] Quotations appearing in the older bee journals of this country listed honey wine at $2.50 a quart and upward.

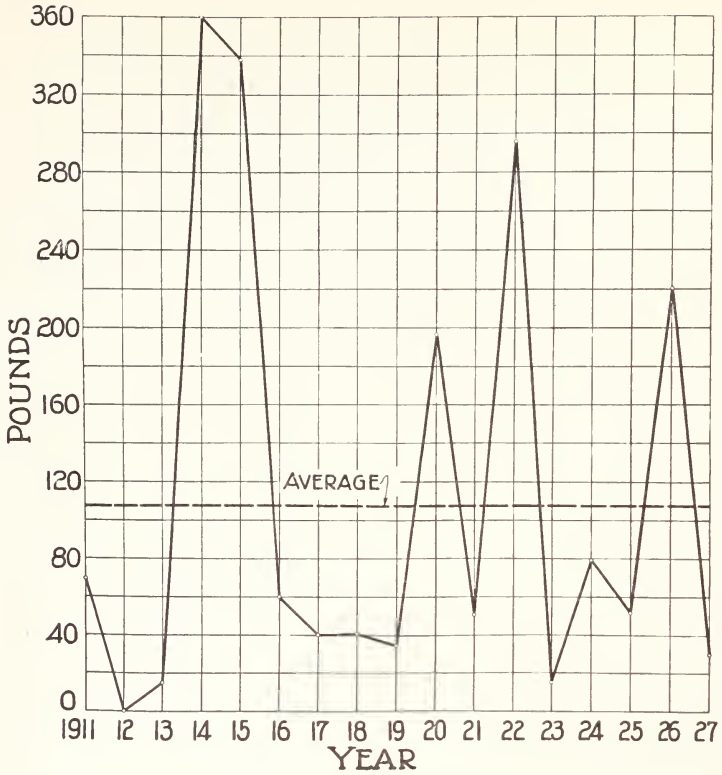

Fig. 8.—Colony production of honey in San Diego County, California.

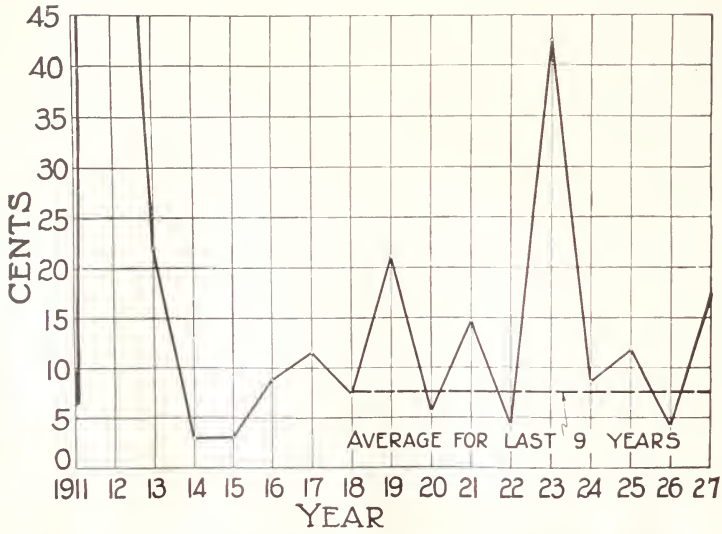

Fig. 9.—Cost of producing honey per pound in southern California.

A glance at figure 8 will show colony production for the years indicated. Some high yields have been obtained, while the production for one season (1912) is zero. A casual comparison of figures 8 and 9 reveals the fact that years of high production are accompanied by lower cost per pound. The truth of the statement that volume production at reduced cost should place the producer in a better financial

Fig. 10.—Bees have been in this San Diego County location continuously since the Civil War. The old-style hive in the foreground is at least sixty years old. The first carload of comb honey shipped from the state was produced in this vicinity.

position cannot be questioned, so long as the price received is not affected by this volume as much as the cost figure or more.

The cost of producing honey depends to a considerable extent upon the kind and abundance of plants in the vicinity. As indicated earlier, to make honey production economically feasible, at least one major honey plant (preferably more) must be present. Southern

California has orange, sages, buckwheats, alfalfa, and Lima beans all within easy moving distance and is therefore much more favorably situated than the Sacramento Valley, for example, where only alfalfa and star thistle are distributed in a spotted manner. Figure 10 shows a location in San Diego County where high yields are often obtained. Figure 11 shows the 1924 and 1926 production of a normal colony on scales at Davis. The plants which yielded the nectar for the honey are indicated with their blossom time. Star thistle is the only honey plant of importance found in range of the bees. Localities without a major honey plant offer no possibilities for money making from

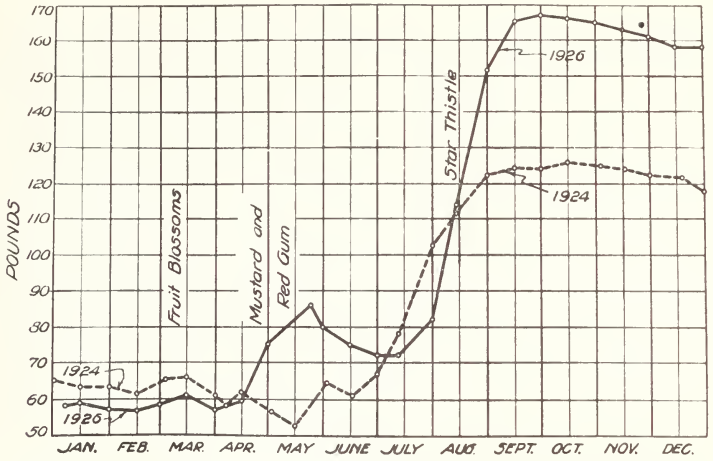

Fig. 11.—Production of honey correlated with plant sources. Data from Davis, California.

bees, because the yield per colony is low with a necessary high cost for the amount obtained.

The production of honey with little attention to the bees is rapidly passing. Certain enemies and diseases, now scattered almost throughout the possible beekeeping areas, necessitate eternal vigilance and drastic action for success. Bees given the requisite attention should certainly prove a profitable sideline, but "sideliners," who are universally accused of dumping their products, may easily make things more difficult for men who must count the cost of production. A selling price maintained in line with current prices in the ordinary channels of trade will prevent much distress.

Those men who take their bees away from southern California during the summer and fall months must procure high yields to continue the practice. Some of the bees go into Utah, Idaho, and other states which permit entry. Considerable pasturage territory is closed

by more or less justifiable quarantine barriers. Uniform regulations outlined by the Western Pest Quarantine Board covering the seven western states would undoubtedly clarify necessary procedure in preparation for movement of bees. Most of the bees carried long distances go by train because of the higher cost of distant trucking. Relatively short hauls are made almost exclusively by motor truck, since only one loading is required. Moving by any method takes costly time and labor.

Land ownership, a large item in the production of most agricultural products, does not especially burden most beekeepers. Locations require no good land and but little space, which can, as a rule, be leased or rented reasonably. The supers are commonly hauled for extraction to a central point where suitable equipment has been installed. If it were not for the land and other favorable items, very few would find honey production profitable at present prices.

National advertising of honey is considered the best method of increasing the consumption. Such increase would naturally tend to raise the producers' price. No agency capable of promulgating this national advertising scheme has yet made its appearance.

REFERENCES FOR FURTHER READING

Many forms of helpful reading material are readily obtainable today. The various agricultural colleges will, upon request, furnish a list of available publications. The United States Department of Agriculture at Washington does likewise. Every beekeeper should subscribe to one or more good journals such as the *American Bee Journal,* Hamilton, Ill.; *Gleanings in Bee Culture,* Medina, Ohio; and *Bees and Honey,* Seattle, Wash. A few of the standard books and bulletins on beekeeping are listed below.

DADANT, C. P., and DADANT, CHAS.
1927. The honey bee (Langstroth). 23rd ed. 438 pp. American Bee Journal, Hamilton, Ill.

DEMUTH, GEO. S.
1919. Commercial comb-honey production. U. S. Dept. Agr. Farmers' Bul. 1039:1–40.
1921. Swarm control. U. S. Dept. Agr. Farmers' Bul. 1198:1–30.

DOOLITTLE, GILBERT M.
1922. Scientific queen rearing. 6th ed. 126 pp. American Bee Journal, Hamilton, Ill.

LOVELL, J. H.
1926. Honey plants of North America. 408 pp. A. I. Root Co., Medina, Ohio.

Nelson, J. A.
1915. The embryology of the honey bee. 282 pp. Princeton Univ. Press.

Pellett, F. C.
1923. American honey plants. 2nd ed. 392 pp. American Bee Journal, Hamilton, Ill.
1923. Productive beekeeping. 3rd ed. 302 pp. J. B. Lippincott Co., Philadelphia.

Phillips, E. F.
1922. Bees. U. S. Dept. Agr. Farmers' Bul. 447:1–44.
1928. Beekeeping. 2nd ed. 490 pp. Macmillan Company, New York.

Root, A. I., and E. R. Root.
1929. ABC and XYZ of bee culture. 815 pp. A. I. Root Co., Medina, Ohio.

Smith, Jay.
1923. Queen rearing simplified. 119 pp. A. I. Root Co., Medina, Ohio.

Snodgrass, R. E.
1925. Anatomy and physiology of the honey bee. 327 pp. McGraw-Hill Book Company, New York.

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